Northern Colorado Plateau Network Herpetofauna Inventory

2002 Annual Report

USGS photo by Renata Platenberg

Blackneck Garter Snake (*Thamnophis cyrtopsis*) at Arches National Park

February 2003

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Summary for 2001 and 2002

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Under the National Park Service Inventory and Monitoring program eleven national parks and monuments in the Northern Colorado Plateau Network were surveyed for the presence of reptiles and amphibians. Eight of these parks received survey effort over two years during 2001 and 2002, while survey effort was initiated in 2002 for the remaining three park units. Second-year parks were Bryce Canyon NP (BRCA), Capitol Reef NP (CARE), Cedar Breaks NM (CEBR), Fossil Butte NM (FOBU), Golden Spike NHS (GOSP), Pipe Spring NM (PISP), Timpanogos Cave NM (TICA), and Zion NP (ZION). First-year parks were Arches NP (ARCH), Colorado NM (COLM), and Natural Bridges NM (NABR). The primary objective of the study was to provide a baseline inventory of herpetofauna in each park with the goal of documenting 90% of species present. A secondary aim is to assess general abundance and distribution of species present, in an attempt to identify park-specific species of special concern.

The primary sampling method across all park units in 2001 and 2002 was general Visual Encounter Survey (VES), with surveyors walking a route or traversing an area, searching for the presence of herpetofauna. Habitat and vegetation characteristics were recorded, and survey routes were georeferenced using GPS. Areas for VES were selected based on habitat type, previously recorded herpetofauna encounters, and accessibility. Attempts were made to sample all gross habitat types present within each park unit and to extend coverage across all regions of the park unit.

In addition to VES, habitat-, time-, and area -constrained searches (TACS) were also carried out in 2001. Sites for sampling within the park unit were provided by the NCPN for five of the eight parks (BRCA, CARE, CEBR, GOSP, and ZION). Using GIS, habitat within the park was stratified according to slope, elevation and aspect, and random points were generated within each habitat type. One-hectare square plots were measured out around these points, and surveyed for two person-hours for the presence of reptiles and amphibians. Surveyors traversed the plot, searching for the presence of herpetofauna using the same search methods as for the VES. Habitat and vegetation characteristics were recorded, and the plots were georeferenced.

Nighttime VES using spotlights were also conducted, primarily for locating breeding amphibians in riparian areas. Under appropriate climatic conditions and where there were suitable road surfaces, we carried out night driving surveys.

Vouchers were collected in the form of photographic slides of every species we were able to capture at each park. Photographs were also taken of individuals that we were unable to capture; those that could be used to positively identify that individual will be submitted as vouchers. All road-kills and other specimens found dead were collected whenever feasible and frozen. Individual voucher specimens have been delivered to Northern Arizona University for processing, and they will be deposited at the Museum of Southwestern Biology at the University of New Mexico in Albuquerque.

During 2001 we spent 965 person-hours on field inventory between May and September. Approximately 340 surveys were carried out, 23% of which were TACS with the remaining being VES, nighttime VES and night driving. We made approximately 2566 individual observations of reptiles and amphibians, and documented 29 species: one salamander, six anurans, 11 lizard species, ten snake species, and one tortoise species.

During 2002 we spent 453 person-hours on field inventory between April and September. Approximately 270 surveys were conducted, 86% of which were diurnal VES with the remaining being nighttime VES and night driving. We did not conduct TACS in 2002. We made approximately 1830 individual observations of reptiles and amphibians, and documented 31 species: one salamander, nine anurans, 13 lizard species, and eight snake species. Due to extreme drought conditions across the northern Colorado Plateau, survey effort was reduced in 2002, but herpetofauna inventories were able to document previously undetected species in four of the eight second-year park units.

In addition to field investigation, limited data mining effort was conducted, as opportunities arose in accordance with field schedules, to locate documentation for species not observed under field investigations. We used data mining results, peer review, and results of field investigations to make revisions to the NPS master species list for each park unit.

Acknowledgements

Many people provided a great deal of assistance to this project, without whom we would not have been able to carry out this work:

Many thanks to the NPS Northern Colorado Plateau Network coordinator Angie Evenden, data manager Margaret Beer, and GIS managers Aneth Wight and Jess Walker, who made all this happen. Additional GIS assistance was graciously provided by Gery Wakefield. Neal Herbert of the NPS South East Utah Group helped with slides and other technicalities.

Southern Colorado Plateau Network, especially the herpetofauna inventory crew lead by Trevor Persons and Erika Nowak, collaborated on many aspects of this project, to ensure data consistency across the Colorado Plateau.

Inventory and Monitoring bird and mammal crews, lead by Matt Johnson and Mike Bogan, respectively, provided field data and moral support.

For peer review of species lists, discussion, and assistance with literature and specimens: Breck Bartholomew, Mike Sears, Geoff Hammerson, George Oliver, Joe Mendelson and the students in his lab at Utah State University, Alice Lindahl, Tim Duck of the BLM at Parashant National Monument, Jack Sites, Kevin Wheeler, Steven Brazier, Gary Skiba, and Steve Wolff.

National Park Service, Utah Division of Wildlife Resources, and the Colorado Division of Wildlife provided the necessary permits.

Many, many thanks to the field crews who helped collect and synthesize the data: Becky Williams, David Syzdek, Jason Bazzano, Brent Trim in 2002; and Rebecca Harms, Jason Leon Jones, and Kim Galvin in 2001. Good job, guys!

And finally, I am indebted to all the people in the National Park Service on the Northern Colorado Plateau: the resource managers, rangers, administration personnel, maintenance staff, librarians, and volunteers who collected specimens, helped find literature, let us use their offices and showers, arranged accommodation for the field crews, accompanied us on surveys, asked questions, and offered us friendship. Their endless enthusiasm in this project made it all worthwhile.

Introduction

The lack of and need for biological information within National Park Service has long been recognized (Sellars, 1997). In response, the National Park Service initiated an Inventory and Monitoring Program in the early 1990's to conduct scientific research and study long-term changes of biological resources in national parks (National Park Service 1992). By the late 1990's most parks still lacked basic biological inventories (National Park Service, 2000). In fiscal year 2000, the National Park Service began efforts to inventory vertebrates and vascular plants nationally. A total of 265 park units were identified as having significant natural resources, and these were divided into 32 "networks" based on geographic proximity and similarity of habitats (Nowak et al, 2002). The many park service units on the Colorado Plateau in Utah, Arizona, New Mexico and Colorado were divided into northern and southern networks for Inventory and Monitoring administration. The Northern Colorado Plateau Network (NCPN) consists of 16 park units in Utah, northern Arizona, western Colorado, and southeastern Wyoming. An inventory plan for vascular plants and vertebrates was developed for these park units (National Park Service, 2000).

The overall objectives of this inventory project are to: (1) document through existing, verifiable data and targeted field investigations the occurrence of at least 90 percent of the species of vertebrates and vascular plants currently estimated to occur in the park; (2) describe the distribution and relative abundance of species of special scientific concern within park boundaries; (3) provide baseline information to develop a general monitoring strategy, tailored to specific park threats and resource issues; and (4) develop coordinated network data management resulting in biological resource information being easily accessible to park managers, resource managers, scientists, and the public (National Park Service, 2000).

The primary objective of the herpetofauna component of the NCPN Inventory and Monitoring Program, which was initiated in 2001, was to provide a baseline inventory of reptiles and amphibians in each park unit with the goal of documenting 90% of species present. A secondary aim is to determine general abundance and distribution of species present, in an effort to identify park-specific species of special concern. The principle emphasis on this project is field investigation, with data mining limited to resources available at the park units visited and those shared by the NCPN.

Northern Colorado Plateau Network park units were divided into two groups: second-year parks, at which survey effort had been initiated in 2001, and first-year parks receiving initial survey effort in 2002. Second-year parks were: Bryce Canyon NP (BRCA), Capitol Reef NP (CARE), Cedar Breaks NM (CEBR), Fossil Butte NM (FOBU), Golden Spike NHS (GOSP), Pipe Spring NM (PISP), Timpanogos Cave NM (TICA), and Zion NP (ZION). First-year parks were: Arches NP (ARCH), Colorado NM (COLM), and Natural Bridges NM (NABR). Four other park units in the Northern Colorado Plateau Network have yet to receive herpetofauna inventory effort: Black Canyon of the Gunnison National Park (BLCA), Canyonlands National Park (CANY), Curecanti National Recreation Area (CURE), and Dinosaur National Monument (DINO). One additional NCPN park unit, Hovenweep NM (HOVE), was included in the I&M

effort of the Southern Colorado Plateau Network (SCPN) for logistical reasons. Figure 1 shows the location of the NCP network park units, identifying first- and second-year parks. In addition to field investigation, a limited amount data mining was conducted to verify species undocumented survey effort, as opportunities arose and when not in conflict with field schedules.

This report comprises a final report for second-year parks and an annual report for the first-year parks.

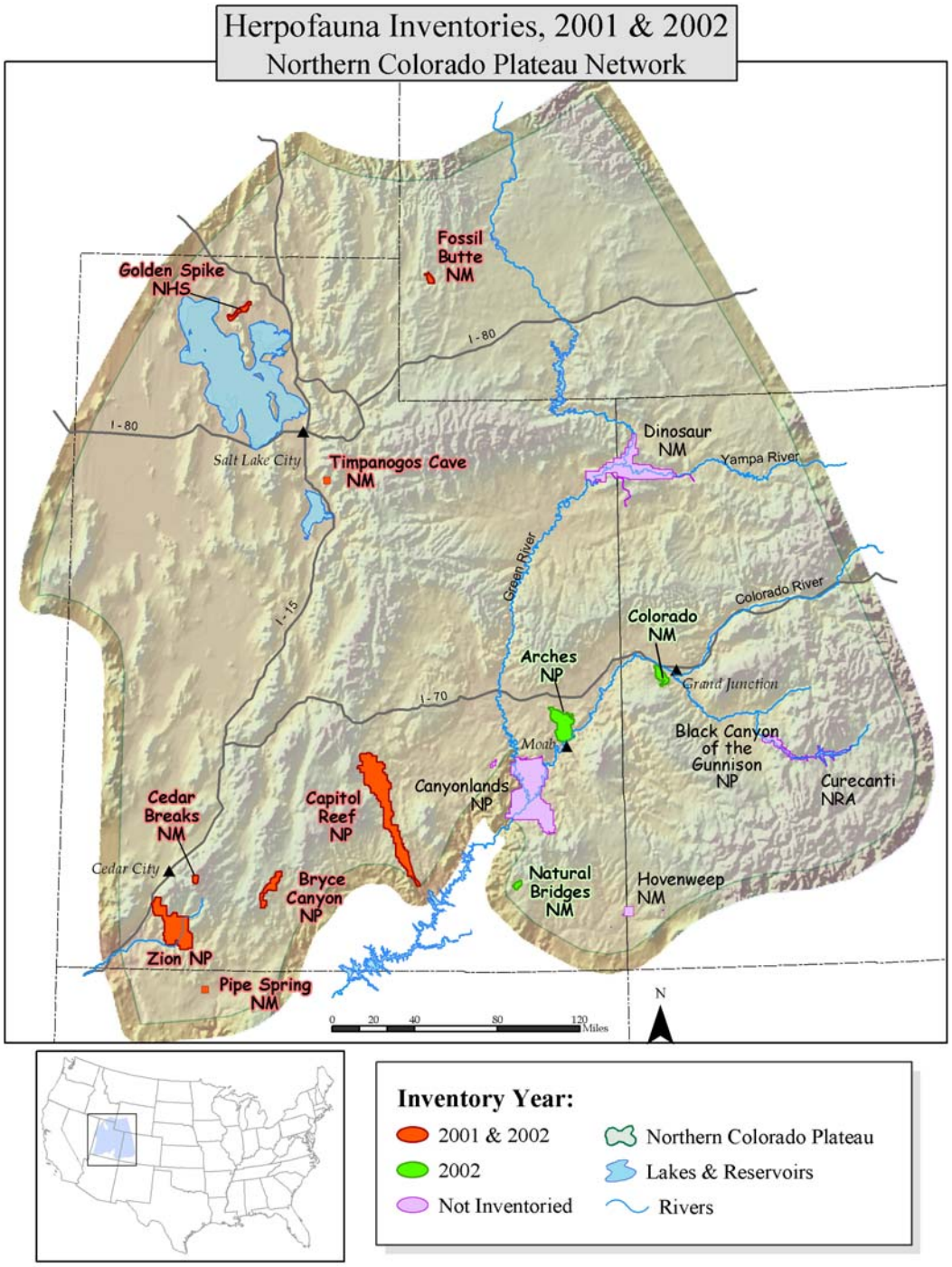

Figure 1. Map showing locations of Northern Colorado Plateau Network national park units. Parks in red were surveyed during two years (2001 and 2002), parks in green were surveyed during one year (2002), and parks in pink have not yet received survey effort.

Methods

Overview

We conducted reptile and amphibian inventories using standard herpetological techniques at eleven national parks and monuments on the northern Colorado Plateau. Survey effort began in 2001 and continued in 2002 for eight of these parks ("second-year parks": BRCA, CARE, CEBR, FOBU, GOSP, PISP, TICA, ZION; Graham and Platenberg, 2001; Nowak et al, 2002). Survey effort was initiated in 2002 for the remaining three parks ("first-year parks": ARCH, COLM, NABR). During the first year of inventory effort, we surveyed all gross habitat types, while during the second year of effort surveys were targeted in specific habitats for specific species. Survey methods were slightly different in 2001 and 2002: in both years survey methods included diurnal visual encounter surveys, nocturnal spotlight surveys, and night road driving, while in 2001 we also conducted randomly located time-and area-constrained searches. For each survey conducted we recorded general weather conditions, location, time, observers, habitat characteristics, and other relevant information. We recorded each individual reptile and amphibian observed during the course of a survey, and recorded interesting observations made during the course of general activities. For each species detected per park, we endeavored to photograph a representative individual, recording morphometric data for each photographic voucher specimen captured.

Target species were identified for second year parks prior to the onset of the field season. These were identified as species not previously documented, but which are likely to occur in the park unit in question, and should be readily observable with a reasonable amount of effort. Biological requirements for these target species were identified through literature searches, and survey plans (timing and location of surveys) were drawn around optimizing encounters.

Park visits were timed to coincide with amphibian breeding events in the spring, and with rain events later in the summer. Because of extreme drought conditions in both 2001 and 2002 there were few summer rain events along the Northern Colorado Plateau, and survey effort was reduced in 2002 in consequence.

Survey methods

The primary sampling method applied across all park units was general Visual Encounter Survey (VES), with surveyors walking a route or traversing an area, searching for the presence of herpetofauna by looking under shrubs, within litter, on rocks, logs and branches, and under rocks, logs, etc.

Nighttime surveys were conducted in selected habitats, where feasible. We used a spotlight to search for specimens in and around water, along trails and roads, in vegetation, and along rocky outcrops. This method is ideal for locating amphibian species, but less optimal for observing reptiles.

Where feasible, we conducted night road driving surveys on both paved and unpaved roads in and around the park boundaries. Night driving is an effective method for locating both reptiles and amphibians in many habitat types, but is less effective in locations where there is a lot of slickrock, which retains heat into the night longer than road surfaces. This technique is also ineffective where there are few roads, or where roads do not pass through all the habitats present in a park. Road driving was not conducted when temperatures at sunset were below 15 ^{o}C. In 2001 we conducted night drive surveys at BRCA, CARE, GOSP, and ZION, but this method proved to be largely unproductive and therefore survey effort was reallocated to different methods. In 2002 we conducted night drive surveys at NABR, COLM, GOSP, and ARCH.

In 2001 we also conducted habitat-, time-, and area -constrained searches (TACs). One-hectare square plots were measured out around randomly selected locations, and surveyed for two person-hours for the presence of reptiles and amphibians. Surveyors traversed the plot, searching for the presence of herpetofauna using the same search methods as for the VES.

Diurnal surveys were carried out under appropriate weather conditions during daylight hours, usually in the early morning and mid to late afternoons, when reptiles are likely to be basking. Hot midday hours were avoided. Nighttime surveys for amphibians were carried out after dusk, regardless of moon phase or weather conditions. Night drive surveys were only conducted when air temperatures at sunset were above 15 ^{o}C.

To optimize survey effort in 2002, we developed a list of target species for each second-year park unit. These were primarily seasonal-breeding amphibians and difficult-to-locate snakes, both groups requiring careful timing of survey effort to coincide with certain weather patterns. We requested park personnel to notify us of weather activity (snowmelt in the spring, rainfall in the summer), and we mobilized survey teams to be on the ground at those locations within 24 hours. We made short-notice visits to FOBU, COLM, NABR, and BRCA as a result of this notification, and were able to locate elusive species at FOBU and COLM.

Selection of survey locations

Selection of sites for sampling was based on diversity and structure of habitat: more complex habitat will likely contain a more diverse herpetofaunal community. Wetlands, creeks, springs and ponds were searched wherever possible for the presence of amphibians, while ridges and rocky outcroppings were productive for locating reptiles. During first-year effort, we attempted to survey each gross habitat present (e.g. riparian, upland grass, upland shrub, talus, etc.) in each park unit, and attempted to extend coverage to all areas of the park (see park maps under park by park results). Survey effort in second-year parks was concentrated in habitats in which we were likely to find previously undocumented species. These decisions were based on biological and habitat requirements of target species, communication with park personnel and other documentation, and accessibility. Attempts were made to survey areas where target species had been previously reported, as determined through records held by the parks,

museum collections or databases, or from anecdotal species accounts. Surveyors frequently accessed remote areas by backpacking.

Areas for VES were selected based on habitat type, previously recorded herpetofauna encounters, and accessibility. Accessible habitat, for the purposes of this project, is defined as those areas to which the survey personnel could negotiate themselves unassisted, e.g., without pack animals or helicopters, and without endangering themselves or others. For example, habitat that occurred on the tops of isolated buttes, halfway up a steep slope, or pockets between steep and rugged terrain (such as between the Waterpocket Fold in CARE) were deemed inaccessible. Parts of TICA were considered inaccessible because of the danger of dislodging rocks onto visitors. Survey crews frequently accessed remote areas by backpacking. Routes to and from random points selected for survey (see below) were also searched, when time allowed. Attempts were made to survey areas where less common species had been reported, as determined through records held by the park or Division of Wildlife, or from anecdotal species accounts.

Sites for TACS were selected based on a list of points randomly generated using GIS. Habitats within five park units (BRCA, CARE, CEBR, GOSP, and ZION) were stratified according to slope, elevation and aspect by the NCPN GIS manager, and random points were generated within each stratification. Points were selected for survey based on accessibility and survey-ability: those points which fell on a steep, inaccessible slope were moved whenever possible to nearby, contiguous terrain. Because of the intended randomness of this survey method, we made no attempt to select points for survey by habitat type or complexity, thus we frequently surveyed plots that would be expected to have low diversity or abundance of herpetofauna, such as dense gambel oak thickets and sandy flats with little or no vegetation.

Survey areas varied in size considerably. All surveys in both 2001 and 2002 were conducted within a single habitat type; TACS were all one hectare, while VES could be anywhere from a small pocket of habitat to an entire riparian drainage several km long. Survey coverage ranged from 0.2 ha to 330 ha (all survey types, including drives) for a total of 2742 ha in 2001, and from 0.04 ha to 102 ha for a total of 1900 ha in 2002.

Data collection

For each survey conducted, we measured air temperature at the start and end of the survey, general weather conditions, cloud cover and wind during the survey, and prevailing weather conditions. Each survey was conducted in a single habitat type, and we recorded the physiognomy class, vegetation type, hydrology, landform type, and soil type. We also identified dominant plant species in herbaceous, shrub and tree layers and estimated percent cover of each layer. For each survey, we subtracted time spent in processing observations, recording UTMs (see below), and other non-survey specific activities. Consequently, for each survey we measured the total time spent conducting the survey and the actual time spent searching for herpetofauna. Each survey was assigned a unique survey number to which all data were referenced.

For each individual encountered during the course of a survey, we recorded time, species, sex, age, detection method, gross habitat type, and microhabitat characteristics. We also noted any interesting behavioral observations. If we encountered an unusual or uncommon species incidentally during the course of travel or other activity, we recorded time and location of encounter only.

We recorded number of individuals and number of species observed per survey. Each individual observed was recorded during the course of a survey, even if the individual could not be identified, and was included in the total count for that survey. For those specimens that could not be identified, we counted them as a separate species only if: a) they belonged to a separate taxon from the other observations (e.g. one lizard and one unidentified snake counted as two species observed), or b) the unidentified individual was very different from the other observations (e.g. three individuals of a small, brown lizard species and one unidentified large spotted lizard counted as two species observed). We did not count as a separate species any individuals that could not with certainty be distinguished from the other species observed (e.g. three individuals of a small, brown lizard species and one unidentified small lizard counted as one species observed).

For the TACS conducted in 2001, habitat and vegetation data were collected for each plot on a standardized form and GPS coordinates were measured at three corners of the plot. We did not measure the UTMs for individual observations within plots.

Documentation of survey locations

To delineate survey location, we recorded UTM coordinates at the start and end of the survey, and consistently throughout the survey. We used either a GARMIN® 12 or GPSIII Plus GPS unit in the datum NAD 27. GPS data were downloaded after each field visit, and we added metadata (survey number, description of waypoint) to the download files. Survey routes were later digitized in ArcInfo. Maps were created by the NCPN GIS manager.

In 2001 we recorded the UTM coordinates for the start and end of the survey route, and for important habitat characteristics along the route. The emphasis in 2001 was more on documenting the location of specimens rather than survey routes, and we did not therefore consistently record location coordinates. In 2002 the emphasis was on documenting the survey routes rather than specimens, and coordinates were consistently recorded. Routes were digitized for both years, based on field notes, route descriptions, UTM coordinates and landscape barriers.

Voucher specimens

Vouchers were collected in the form of photographic slides of every species we were able to capture at each park. Photographs were also taken of individuals that we were unable to capture; those that could be used to positively identify that individual will be submitted as vouchers. Where possible, morphometric measurements (snout to vent length, tail length, mass) were taken for vouchered (photographed) specimens, which were then

released unharmed. All road-kills and other specimens found dead were collected whenever feasible and frozen. Individual voucher specimens have been delivered to Northern Arizona University for processing. These will be given NPS accession numbers, and deposited at the Museum of Southwestern Biology at the University of New Mexico, Albuquerque.

Data management

Survey, observation, GPS, and photographic voucher data were entered into four separate Excel spreadsheets, referenced to each other by survey number. These spreadsheets were developed by the survey crew, based on data collected in the field; we were not supplied a database structure by the NCPN.

Data analysis

We assessed sampling effort, survey effectiveness, survey progress and inventory completeness. The amount of sampling effort was measured as the number of hours spent on each survey multiplied by the number of people involved in that survey, to give person-hours of survey. In 2001 survey time included time spent on activities other than searching for specimens, e.g. map reading, recording of UTMs and habitat characteristics, identifying and processing specimens. In 2002 we recorded the time spent carrying out these peripheral activities for each survey, and subtracted this from the total time spent on survey. This time amounted to approximately 20% of all surveys, and to compare effort between years, 20% was subtracted from survey times for 2001 data.

We used capture rate per unit effort to determine survey effectiveness, by taking the number of observations divided by the number of person-hours of survey, and assessed survey results by park and by gross habitat type surveyed within each park unit.

To assess survey progress we compiled species accumulation curves for each park, combining both years of data for second year parks. To estimate inventory completeness, we compared number of species documented in each park unit against a master list of species expected to occur in that unit. These master lists have been refined since they were first generated (see discussion section on how the list was developed), and we compared our results with the refined list to produce a percentage of completion.

Finally, we analyzed inventory completeness in relation to effort across all park units on the NCP surveyed in 2001 and 2002. These analyses were designed to determine if differing levels of inventory success was a function of time spent in the field, or if other park-specific factors were at play in determining success rates. We used regression analyses to determine the relationship between percentage completion with person-hours of effort.

Revision of the master species list

Prior to the start of the surveys, Graham (2000) developed a target species list for each park, with each entry annotated as to whether it had been personally observed, appeared on park species lists, or was possible to occur in the park based on distribution (assessed from Stebbins, 1985). This list included those species that were not known from the locality, but might be a range extension and should therefore be included on a watch list. These species were added to the master list already held by the NPS as species occurring in the park units. This master list contained data from a variety of sources, including species lists developed by experienced field biologists, and observation records from individual park units, historical records, and anecdotal accounts. Taxonomic synonyms were common throughout the list, with each name counted as separate species even when referring to the same species. The list also contained species that could not have been observed in the location in which they were attributed, and must be false reports due to misidentification. We have revised this master list, using Graham (2000) as a basis, using relevant literature, field investigation, and peer review.

After the 2001 field season, the master list and list of species documented in the first eight parks surveyed (BRCA, CARE, CEBR, FOBU, GOSP, PISP, TICA, and ZION) were sent for peer review. Comments were returned from George Oliver (Utah Division of Wildlife Resources, Heritage Program), Mike Sears (University of Nevada at Reno), Breck Bartholomew (Society for the Study of Amphibians and Reptiles), and Joe Mendelson III (Utah State University). Each consultant has personal experience with the herpetofauna of Utah. Where two or more experts agreed that a particular species would not occur in a particular park unit, that species was removed from the list. The species was left in place if no comments were made, and questionable status was assigned if the expert opinions did not agree. Additional comments were received from Alice Lindahl (Utah State University), Trevor Persons (Northern Arizona University), and Geoffrey Hammerson (formerly with The Nature Conservancy). The master lists for the parks not surveyed during 2001 did not go through this review process

For both groups of parks, natural history accounts of species not documented during the field seasons were examined and compared with the habitats available within the park units. Aspects such as vegetation association and elevation range were assessed, using information from Stebbins (1985) and from peer reviewed published accounts (e.g. Beck 1990; Tinkle 1972, 1976). Those species not likely to occur within the individual park units due to lack of suitable habitat were listed as candidates for removal from the master list.

At the end of the 2002 field season, the master lists were once again revised, based on further data mining and field experience. Species were removed from the list if they were (a) not likely to occur due to elevation/distribution range, (b) not likely to occur due to unavailability of habitat types or features present within the park unit boundaries (e.g. suitable breeding sites for amphibians, regardless of habitat type), and (c) not historically recorded from within the park boundaries in published accounts or other reliable sources. Species were put on a “watch list” if there was insufficient information available to

determine presence or absence from the park unit, and these were not included in measurements of inventory effort completeness.

The master list for the first-year parks (ARCH, COLM, NABR) was also revised, based on findings during field survey, data mining, and consultation with experts, according to the above criteria. These park units have previously received a considerable amount of herpetological attention, and are fairly well documented. We feel that the current species list is a fair representation of the reptiles and amphibians present for these three park units.

For those park units not surveyed in 2001 or 2002 (BLCA, CANY, CURE, DINO), the species list consultation process has yet to be completed. Recommendations for the species list for these parks are based on published accounts and ecological and range information from Stebbins (1985) and Hammerson (1999).

Appendix 1 contains the master species list, recommendations for revision, and summaries of documentation for each NCPN park unit.

A list of species and abbreviations used in this text are listed in Appendix 2. Nomenclature used in this report conforms to the most recently published reference on scientific and common names of North American herpetofauna (Collins and Taggart, 2002). For certain species we preferred to use alternative and more commonly accepted nomenclature as listed in a previous reference produced by the Committee on Standard English and Scientific Names (2000). We have noted these exceptions in the master species list.

Literature review and data mining

During the course of the two field seasons, we have endeavored to collect as much information on the herpetofauna of the NCPN parks as possible. This has involved locating museum collections and acquiring specimen information, examining the observation cards and databases held by the individual parks, searching associated databases maintained by the state natural resource offices (e.g. Utah Division of Wildlife Resources and Colorado Division of Wildlife), and locating published articles from scientific journals and gray literature. In addition, we have communicated extensively with current and former park personnel and volunteers, biologists from other agencies (e.g. US Forest Service, UDWR, BLM), university scientists, and directly with authors of relevant literature. We have relied heavily on field guides (Baxter and Stone, 1985; Hammerson, 1999; Stebbins, 1985) for information on habitat requirements, distribution range, and ecology of individual species. Data mining results are summarized in the master species list spreadsheet.

Individual Park Findings: Second-year Parks

The accounts that follow summarize the field effort and findings in each of the park units that received two years of survey. They include maps of the park units, showing the entire park unit and survey routes for both years, and enlargements of subsections of the park. Each enlargement shows routes color-coded by survey type (VES, night VES, TAC, and night drive), and labeled according to survey number, date, and number of observations to number of species observed. On occasion it was not possible to identify a specimen to species, these unidentified observations were included in the total observations for that survey. Number of species included all observations we were able to identify, unidentifiable observations that were of a different taxon, and unidentifiable observations that could not be included in with other species observed during that particular survey. If it was not possible to distinguish uniqueness of species, the species was not included in final tally (e.g. two unidentified small brown lizards, one unidentified snake, and one unidentified large striped lizard were counted as four observations of three species).

Appendix 3 lists the field survey schedules for 2001 and 2002. Appendix 4 summarizes the experience and qualifications of the field survey personnel.

Bryce Canyon National Park

During 2001 we conducted 59 surveys over four visits to BRCA, 23 of which were one-hectare TACS. We documented four lizard and two snake species (table 1) from a total of 114 observations.

Survey priorities for 2002 were to locate amphibians and any snake species not documented in 2001. We conducted 30 surveys over four visits and made 60 individual observations; due to extreme drought conditions, we did not spend a considerable amount of time at this park unit during 2002. We added one species to the list of those documented last year, the northern leopard frog (*Rana pipiens*). In addition, western toads (*Bufo boreas*) were documented in the Sevier River drainages of the Dixie National Forest to the west of the park boundary, although it is unlikely that this species occurs within the park. No specimens were collected from this park during this inventory.

Figure 2 shows the level of effort expended in person-hours (time multiplied by the number of surveyors) in survey according to habitat type in 2002. Most of survey effort was conducted in ponderosa pine woodland, the predominant habitat type at BRCA, while mountain mahogany-oak shrublands proved to be the most productive for herpetofauna sightings. Figure 3 (a-f) shows survey locations by survey type in BRCA for both 2001 and 2002.

Estimated inventory completeness for BRCA is 54%. There are six potential species undocumented by field effort in this park: tiger salamander (*Ambystoma tigrinum*), Great Basin spadefoot (*Spea intermontana*), whipsnake (*Masticophis taeniatus*), western skink (*Eumeces skiltonianus*), western whiptail (*Cnemidophorus tigris*), and the western rattlesnake (*Crotalus viridis*). Other documentation for these species is either speculative and unverified (e.g. Wilhelm, 1967) or outdated (e.g. Tanner, 1930). We recommend that further inventory effort be allocated to locating these species.

Table 1. Amphibian and reptile species observed at BRCA in 2001 and 2002. An asterisk (*) denotes that a photo voucher has been collected for this species. Species in boldface had not been previously documented by the present inventory, species followed by a (‡) were observed only in 2001.

BRYCE CANYON NATIONAL PARK	
AMPHIBIANS	
***Northern Leopard Frog**	***Rana pipiens***
LIZARDS	
*Mountain Short Horned Lizard	*Phrynosoma hernandesi*
*Sagebrush Lizard	*Sceloporus graciosus*
*Eastern Fence Lizard	*Sceloporus undulatus*
*Tree Lizard	*Urosaurus ornatus*
SNAKES	
*Gopher Snake‡	*Pituophis catenifer*
*Wandering Garter Snake‡	*Thamnophis elegans vagrans*

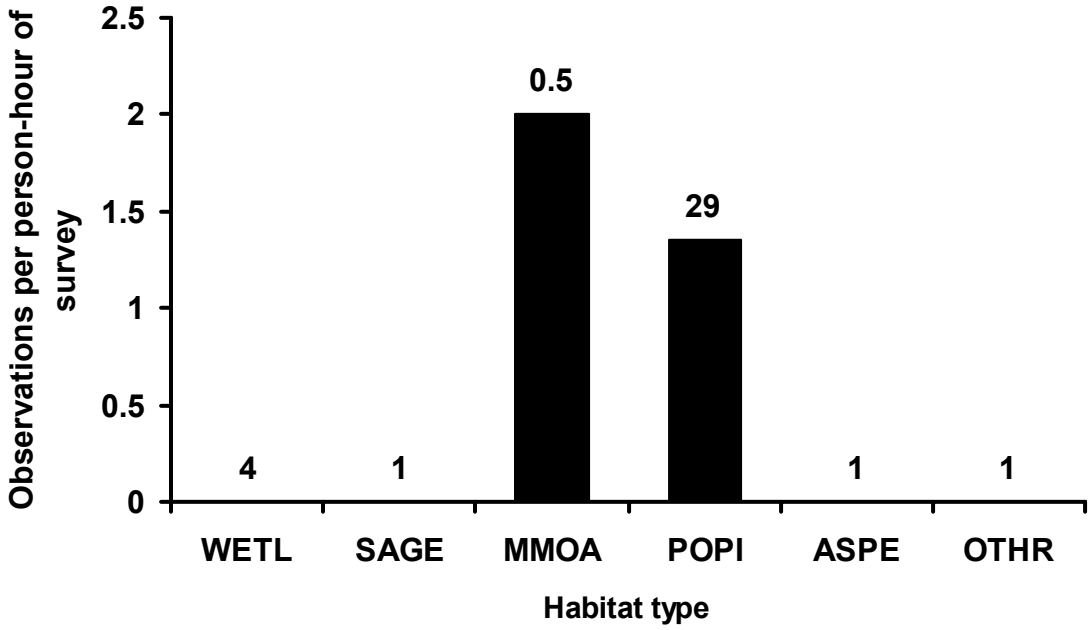

Figure 2. Survey effectiveness among habitat types sampled in BRCA during 2002. **WETL** = Wetland; **SAGE** = Great Basin sagebrush; **MMOA** = Mountain mahogany-oak shrublands; **POPI** = Ponderosa pine woodlands and forest; **ASPE** = Aspen forest; **OTHR** = Other habitat types. Numbers appearing over bars denote number of person-hours of survey expended in each habitat type.

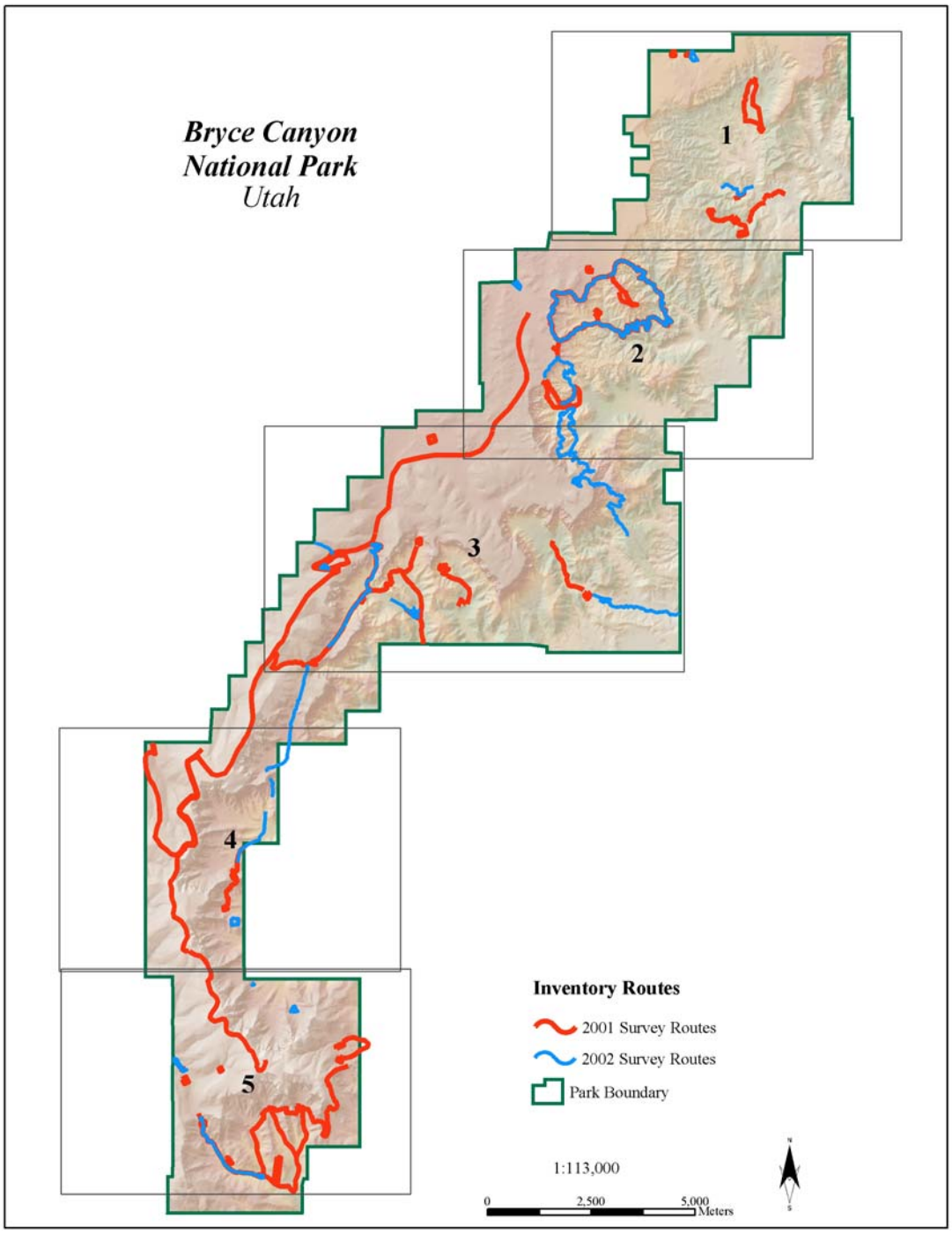

Figure 3a. Herpetofauna inventory effort in Bryce Canyon National Park in 2001 and 2002. Numbered insets refer to subsequent maps detailing survey information.

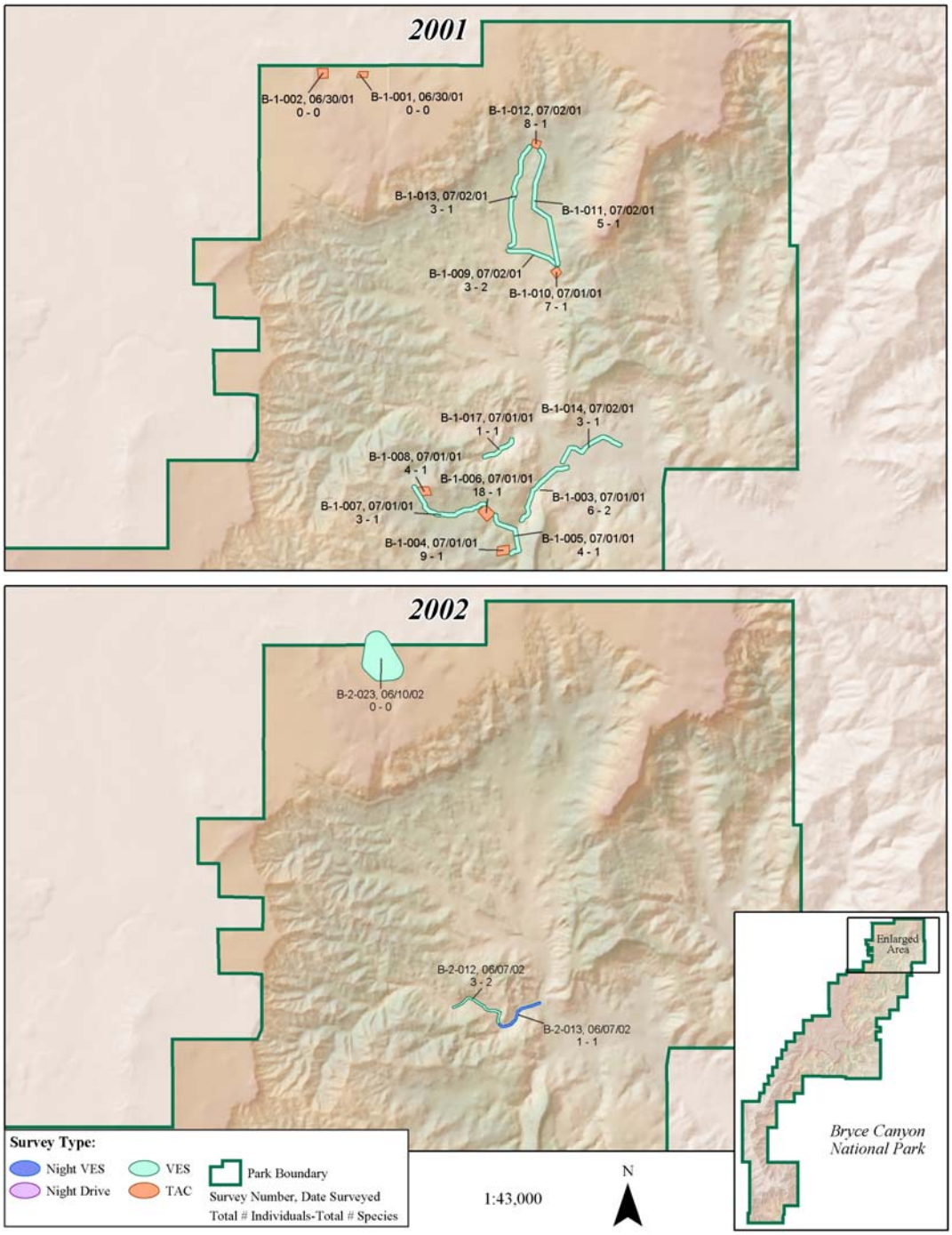

Figure 3b. Herpetofauna inventory effort in Bryce Canyon National Park, subsection 1. Line color depicts survey type, width of line shows survey coverage. Lines are labeled with survey number, date, and number of individual observations to number of species observed.

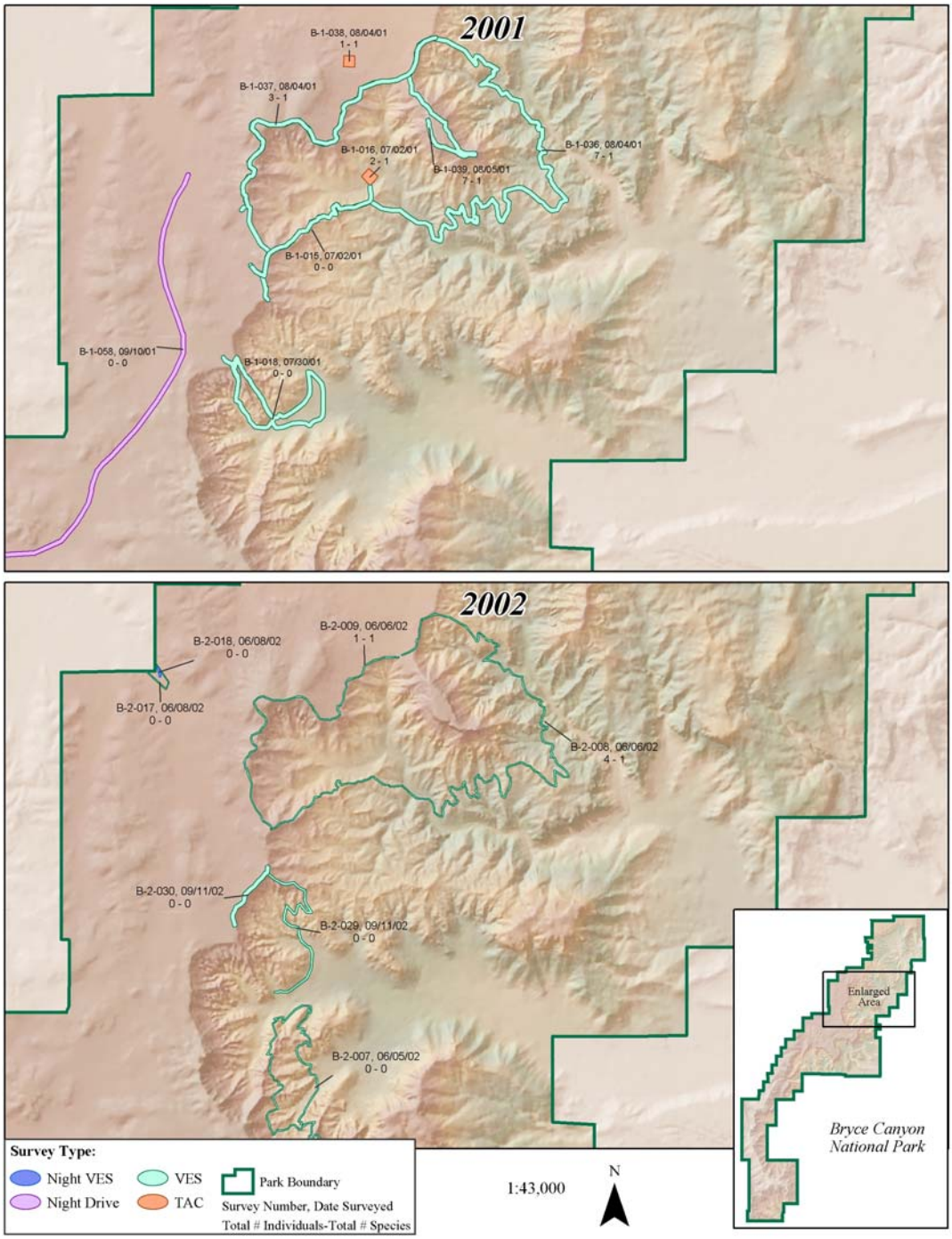

Figure 3c. Herpetofauna inventory effort in Bryce Canyon National Park, subsection 2. Line color depicts survey type, width of line shows survey coverage. Lines are labeled with survey number, date, and number of individual observations to number of species observed.

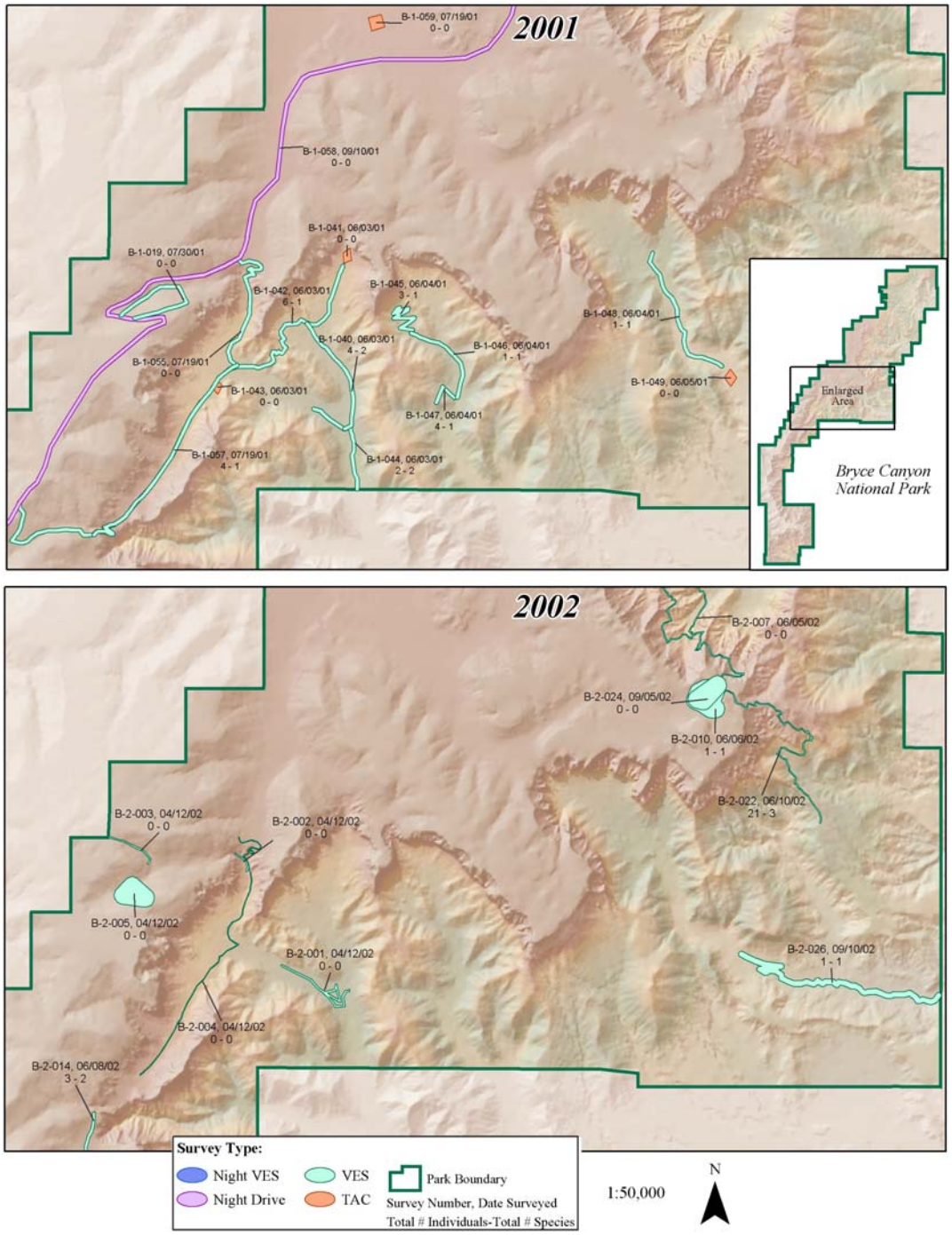

Figure 3d. Herpetofauna inventory effort in Bryce Canyon National Park, subsection 3. Line color depicts survey type, width of line shows survey coverage. Lines are labeled with survey number, date, and number of individual observations to number of species observed.

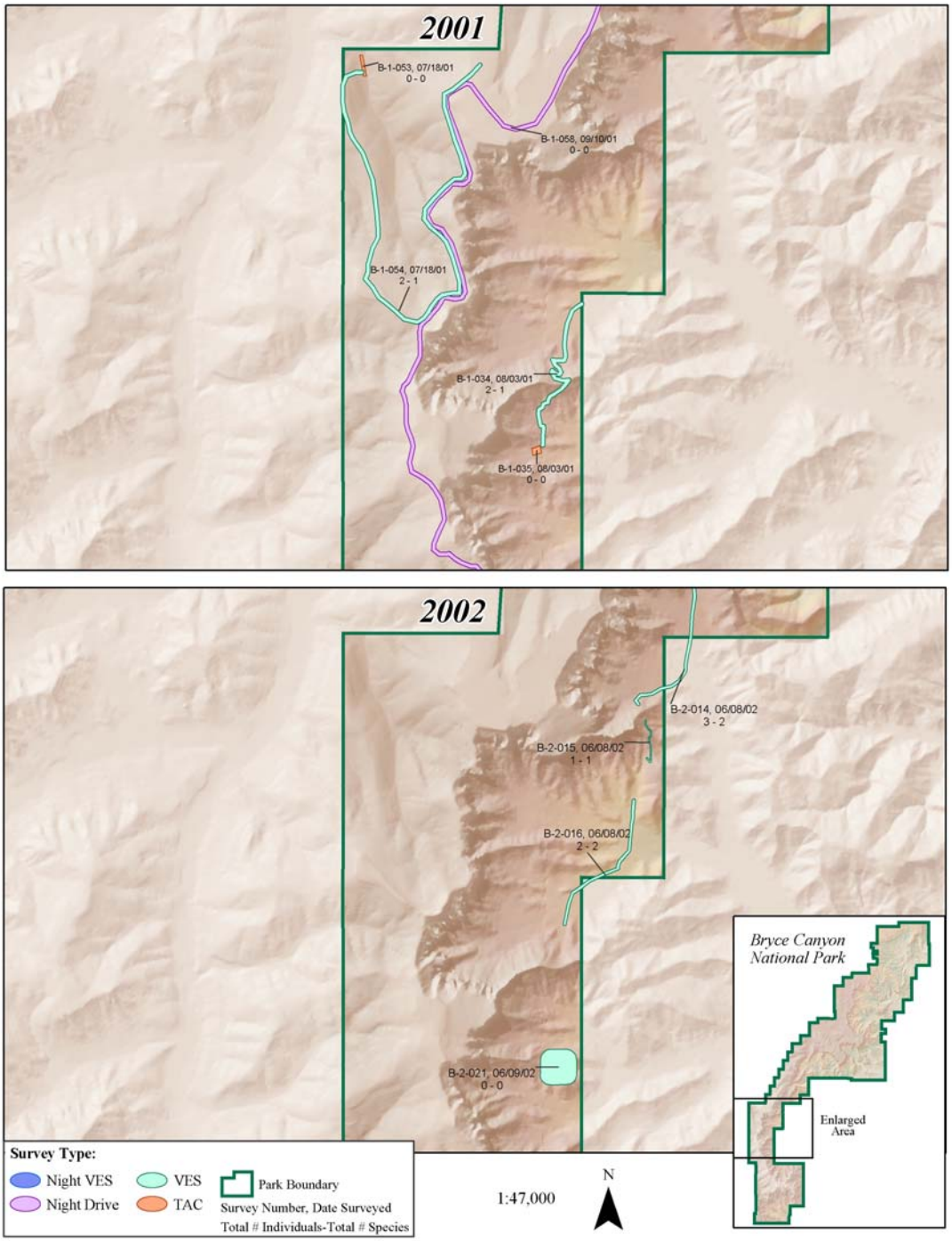

Figure 3e. Herpetofauna inventory effort in Bryce Canyon National Park, subsection 4. Line color depicts survey type, width of line shows survey coverage. Lines are labeled with survey number, date, and number of individual observations to number of species observed.

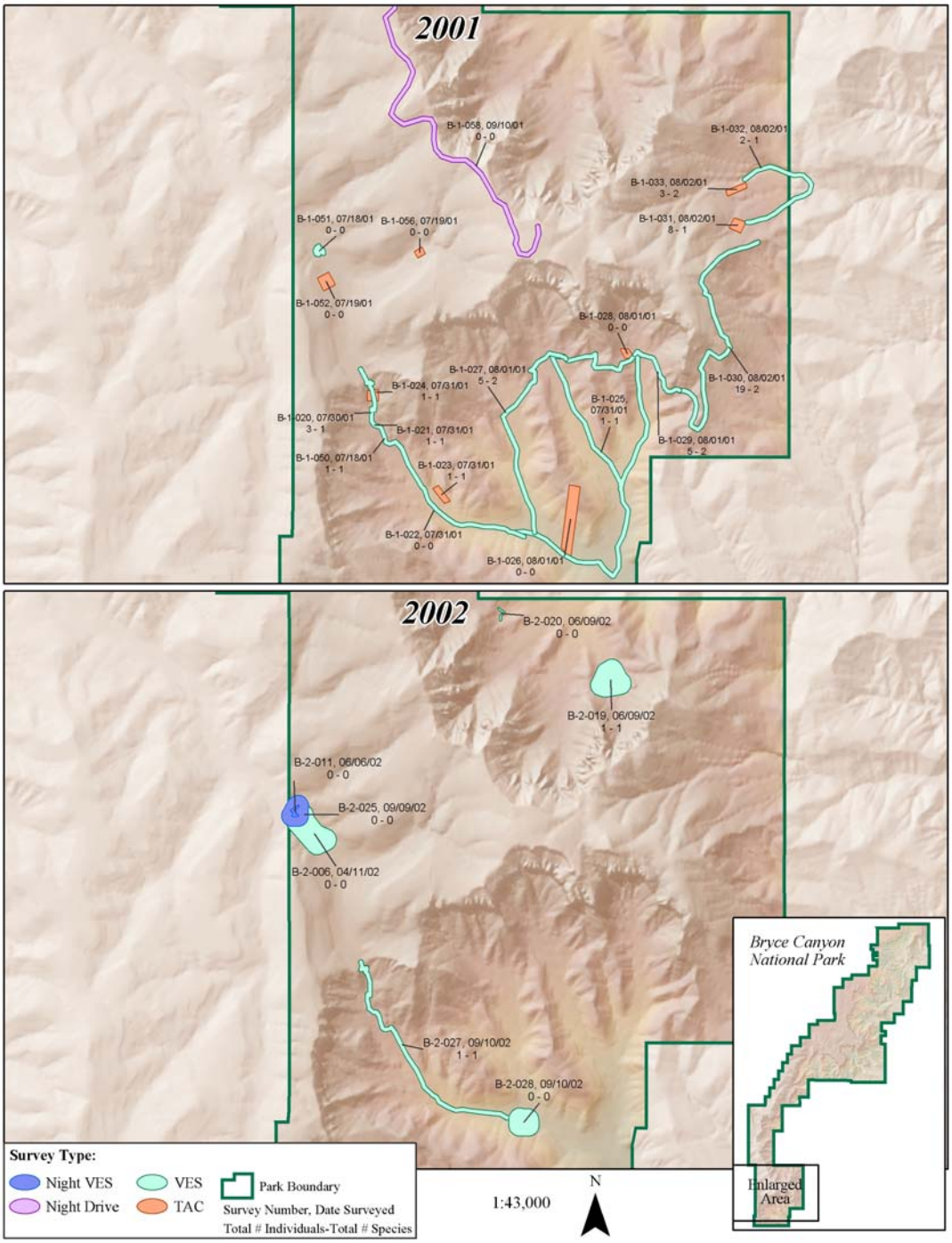

Figure 3f. Herpetofauna inventory effort in Bryce Canyon National Park, subsection 5. Line color depicts survey type, width of line shows survey coverage. Lines are labeled with survey number, date, and number of individual observations to number of species observed.

Capitol Reef National Park

During 2001 we conducted 98 surveys over eight visits to CARE, 21 of which were one-hectare TACS. We documented four amphibian, 10 lizard and five snake species (table 2) from a total of 1254 observations. We collected four voucher specimens.

Survey priorities for 2002 were to locate leopard frogs (*Rana pipiens*) and tiger salamanders (*Ambystoma tigrinum*), as well as any snake species not already documented. We conducted 27 surveys over three visits, making 238 individual observations, but were unable to locate any species not already documented. No specimens were collected from this park unit during 2002.

Figure 4 shows the level of effort expended in person-hours (time multiplied by the number of surveyors) in survey according to habitat type in 2002. Most of survey effort was spent in riparian areas, while mountain mahogany-oak shrublands proved to be the most productive for herpetofauna sightings. Figure 5 (a–n) shows survey locations by survey type in CARE for both 2001 and 2002.

Estimated inventory completeness for CARE is 83%. Four potential species remain undetected by field effort: tiger salamander (*Ambystoma tigrinum*), leopard frog (*Rana pipiens*), night snake (*Hypsiglena torquata*), and southwestern blackhead snake (*Tantilla hobartsmithi*). Tiger salamanders and leopard frogs were documented in CARE as recently as the late 1980's (A. Lindahl, pers. comm.). Leopard frogs were observed during a survey of the Fremont River Oxbow in 1998 (Anonymous, 1998) but we have found no reports of observations of either of these species since. The Oxbow riparian zone has been encroached by tamarisk (*Tamarix chinensis*) and subject to desiccation since 1994 (Anonymous, 1998), and there was a severe drought in the region in the late 1980's to early 1990's. It is possible that both species have been extirpated from this park unit. This is a potentially significant finding, as these amphibians, while not common, persist in other areas of the northern Colorado Plateau, including the Grand Staircase Escalante National Monument (T. Graham, unpubl. data), and are important indicators of the health of an arid ecosystem. They should be placed on a high-priority watch list, and we recommend further effort to locate these two species.

There is one other species that does not appear on the master list for CARE, but should be noted. The chuckwalla (*Sauromalus obesus*) was historically reported from Glen Canyon and its tributaries (Woodbury, 1959) as far up as Hite (Woodbury, 1958). However, we were unable to locate any documentation for this species in this region since the creation of Lake Powell. There has been only one recent observation of this species, from the southeastern section of the Grand Staircase Escalante National Monument in 2001 (G. Oliver, pers. comm.). Although we have removed this species from the master list, it should remain on a watch list.

Two other lizards that should be placed on a watch list are the night lizard (*Xantusia vigilis*) and the western skink (*Eumeces skiltonianus*). The night lizard is extremely

secretive and difficult to locate, but it might occur in the southern segment of CARE. The skink may occur in the northern segments of the park, in the higher elevations.

Table 2. Amphibian and reptile species observed at CARE in 2001 and 2002. An asterisk (*) denotes that a photo voucher has been collected for this species. Species in boldface had not been previously documented by the present inventory, species followed by a (‡) were observed only in 2001.

CAPITOL REEF NATIONAL PARK	
AMPHIBIANS	
*Red-spotted Toad‡	*Bufo punctatus*
*Woodhouse's Toad‡	*Bufo woodhousii*
*Canyon Treefrog‡	*Hyla arenicolor*
*Great Basin Spadefoot‡	*Spea intermontana*
LIZARDS	
*Western Whiptail	*Cnemidophorus tigris*
*Plateau Striped Whiptail‡	*Cnemidophorus velox*
*Great Basin Collared Lizard	*Crotaphytus bicinctores*
*Longnose Leopard Lizard	*Gambelia wislizenii*
Mountain Short Horned Lizard‡ documentation provided by park personnel	*Phrynosoma hernandesi*
*Sagebrush Lizard	*Sceloporus graciosus*
*Desert Spiny Lizard	*Sceloporus magister*
*Eastern Fence Lizard	*Sceloporus undulatus*
*Tree Lizard	*Urosaurus ornatus*
*Side-blotched Lizard	*Uta stansburiana*
SNAKES	
*Midget Faded Rattlesnake‡	*Crotalus viridis concolor*
Common Kingsnake‡	*Lampropeltis getula*
*Striped Whipsnake	*Masticophis taeniatus*
*Gopher Snake‡	*Pituophis catenifer*
*Wandering Garter Snake	*Thamnophis elegans vagrans*

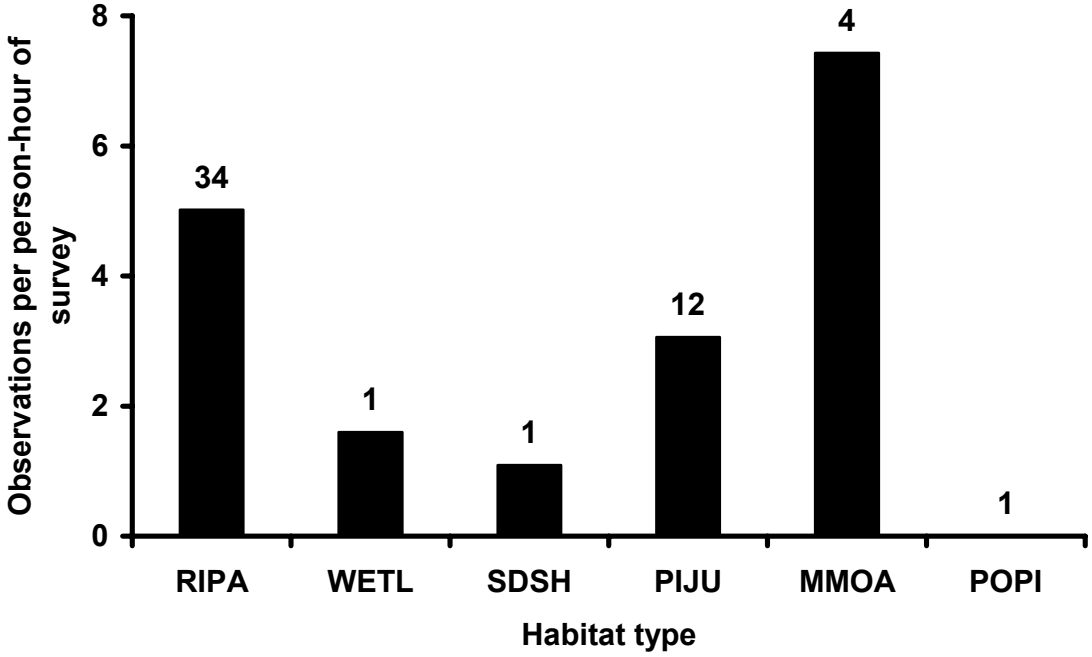

Figure 4. Survey effectiveness among habitat types sampled in CARE during 2002. **RIPA** = Riparian and canyon woodlands; **WETL** = Wetland; **SDSH** = Salt desert scrub; **PIJU** = Pinyon-juniper woodlands; **MMOA** = Mountain mahogany-oak shrublands; **POPI** = Ponderosa pine woodlands and forest. Numbers appearing over bars denote number of person-hours of survey expended in each habitat type.

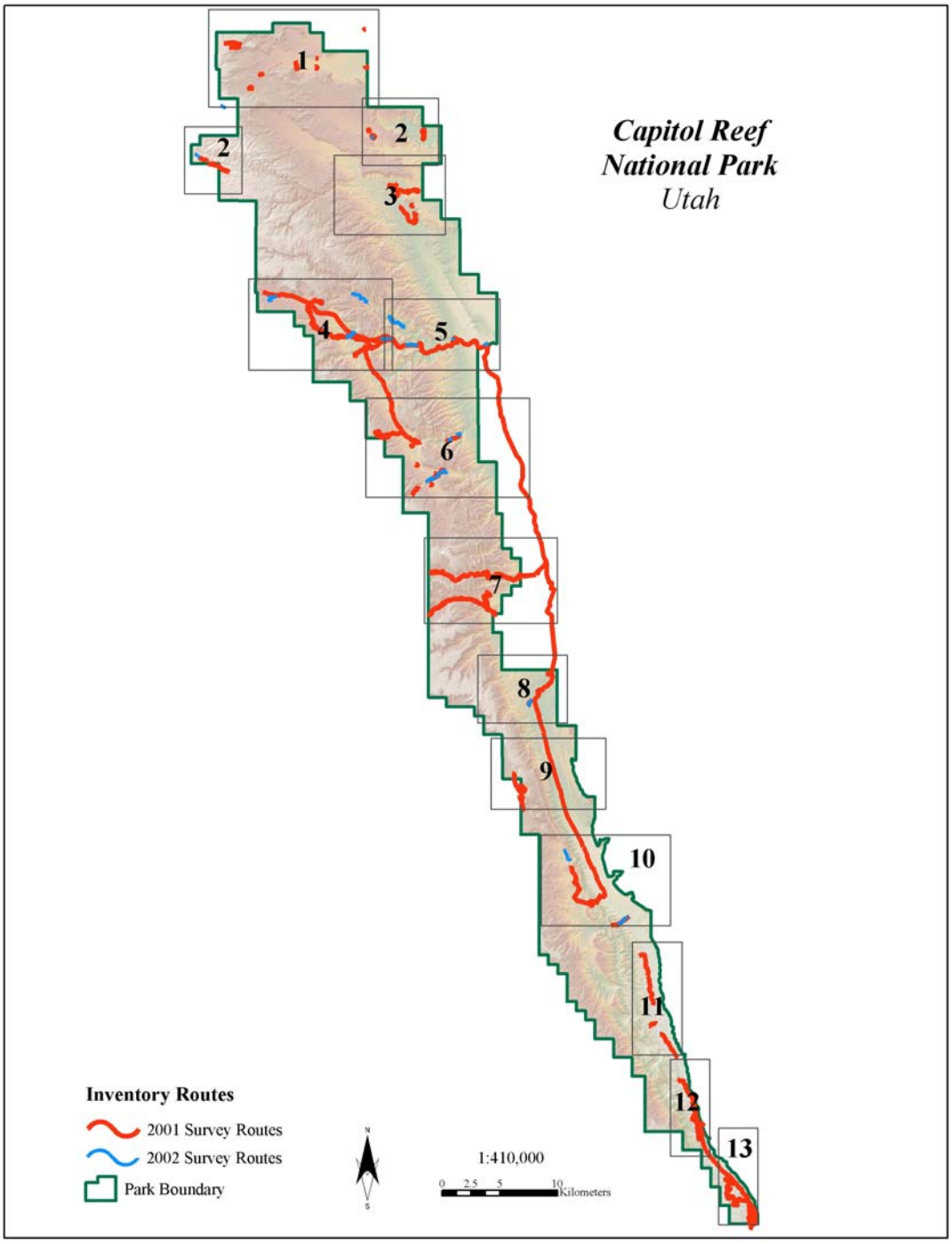

Figure 5a. Herpetofauna inventory effort in Capitol Reef National Park in 2001 and 2002. Numbered insets refer to subsequent maps detailing survey information.

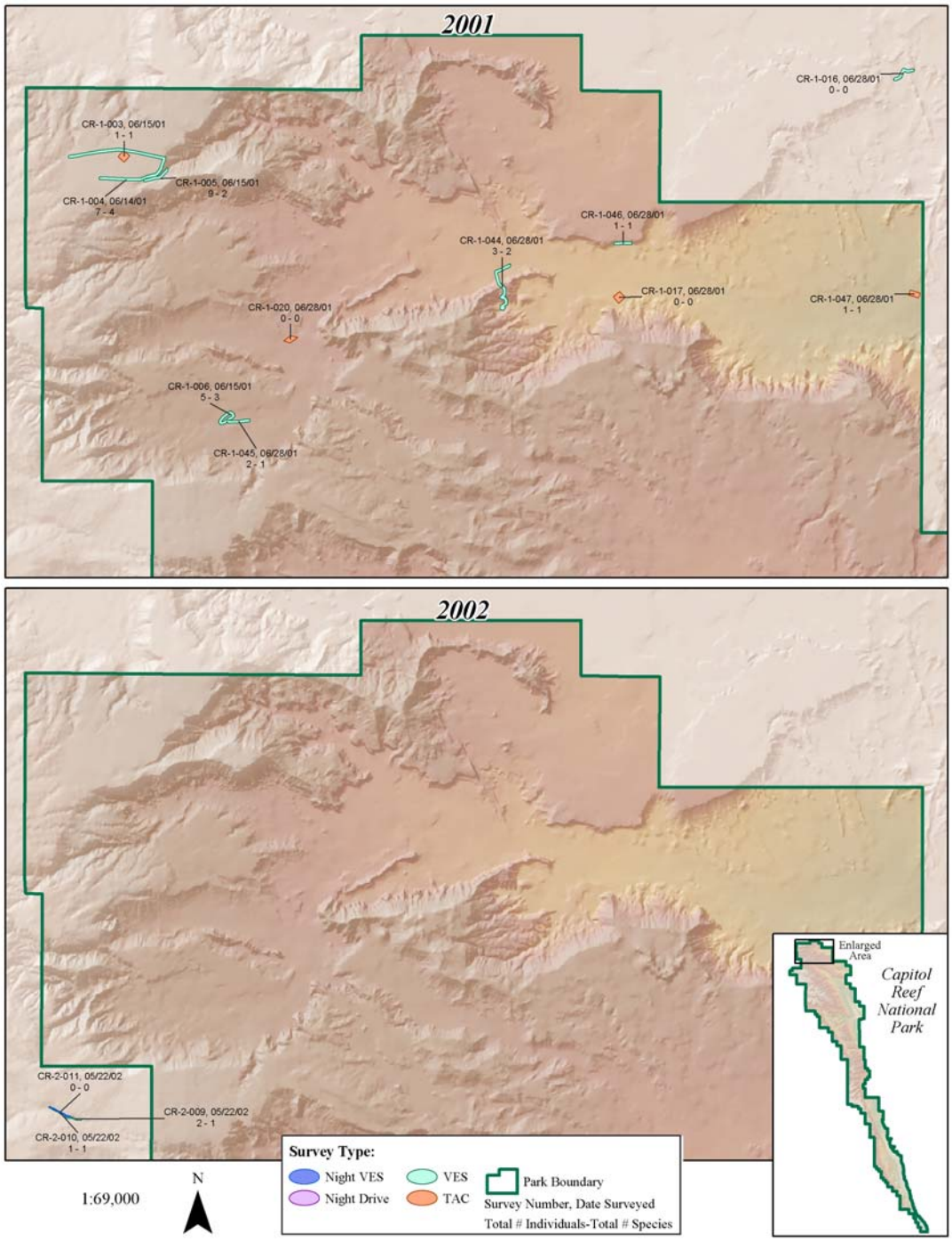

Figure 5b. Herpetofauna inventory effort in Capitol Reef National Park, subsection 1. Line color depicts survey type, width of line shows survey coverage. Lines are labeled with survey number, date, and number of individual observations to number of species observed.

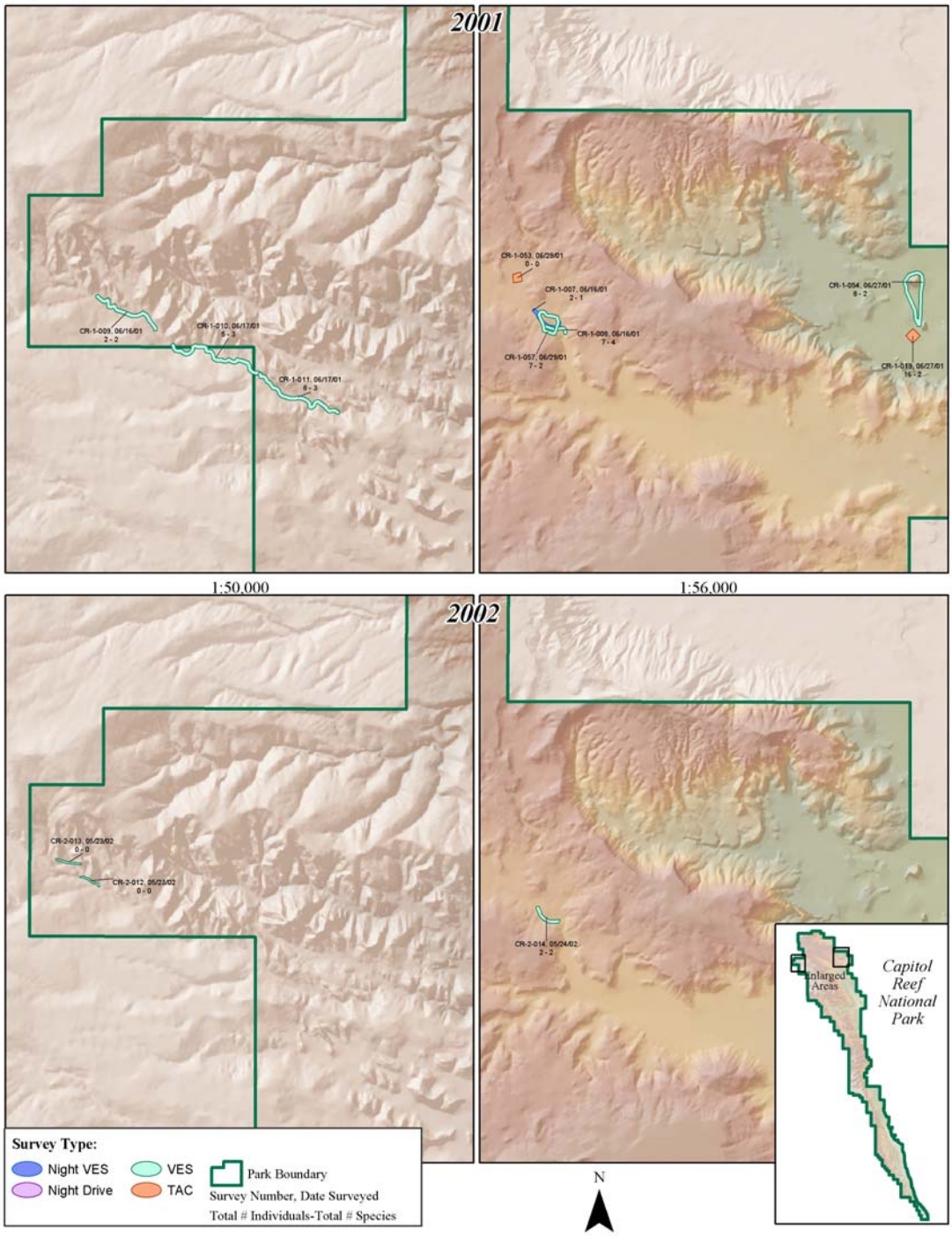

Figure 5c. Herpetofauna inventory effort in Capitol Reef National Park, subsection 2. Line color depicts survey type, width of line shows survey coverage. Lines are labeled with survey number, date, and number of individual observations to number of species observed.

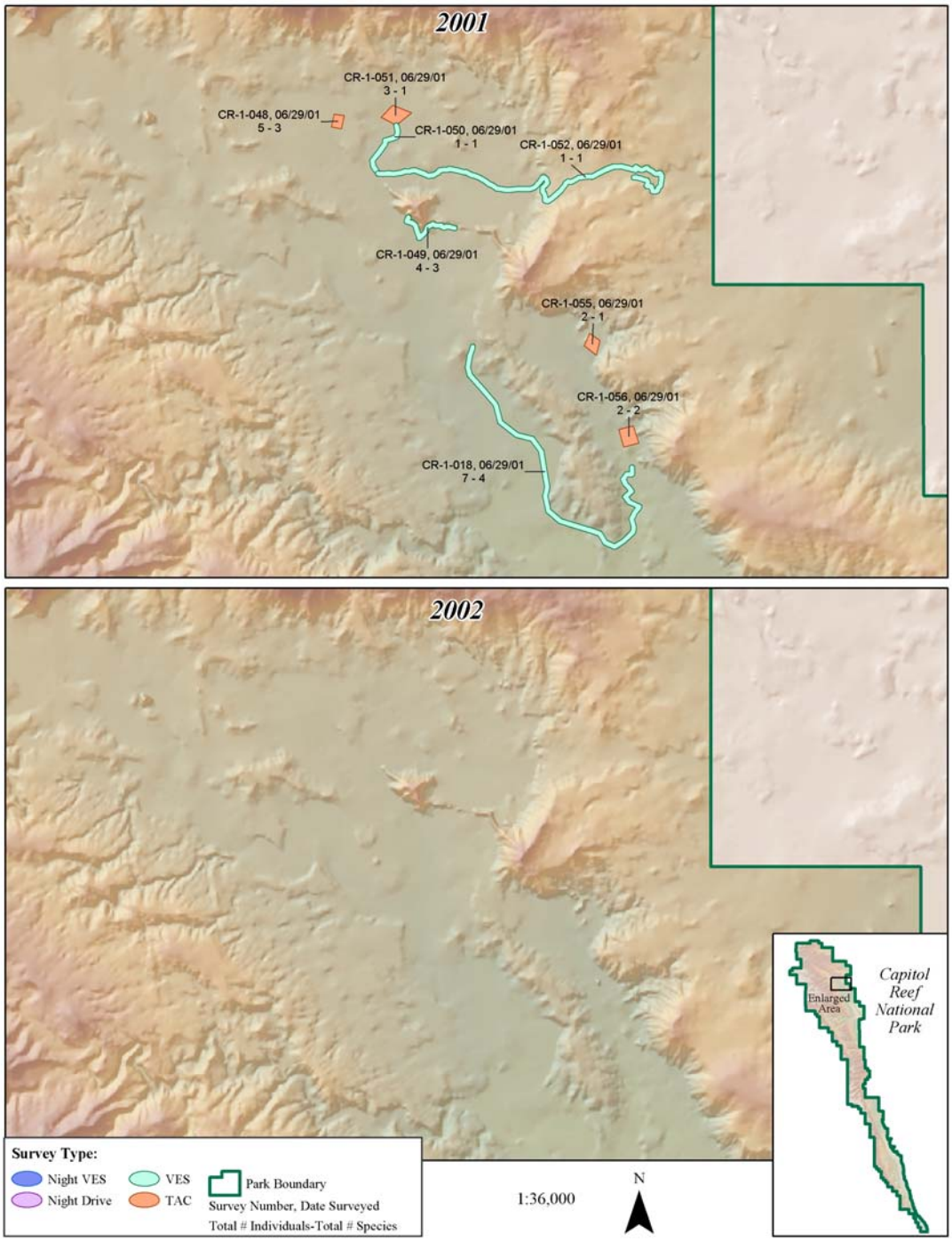

Figure 5d. Herpetofauna inventory effort in Capitol Reef National Park, subsection 3. Line color depicts survey type, width of line shows survey coverage. Lines are labeled with survey number, date, and number of individual observations to number of species observed.

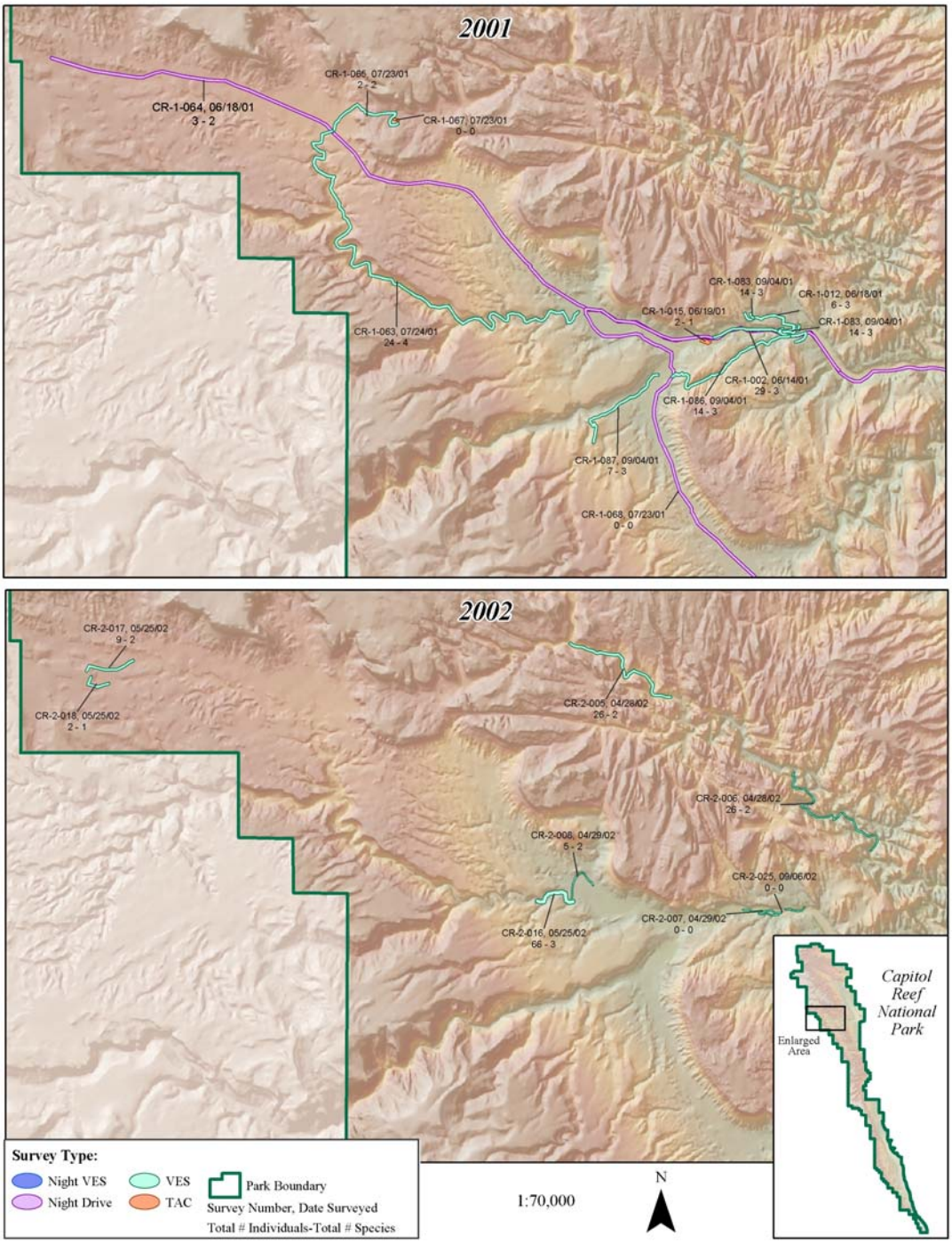

Figure 5e. Herpetofauna inventory effort in Capitol Reef National Park, subsection 4. Line color depicts survey type, width of line shows survey coverage. Lines are labeled with survey number, date, and number of individual observations to number of species observed.

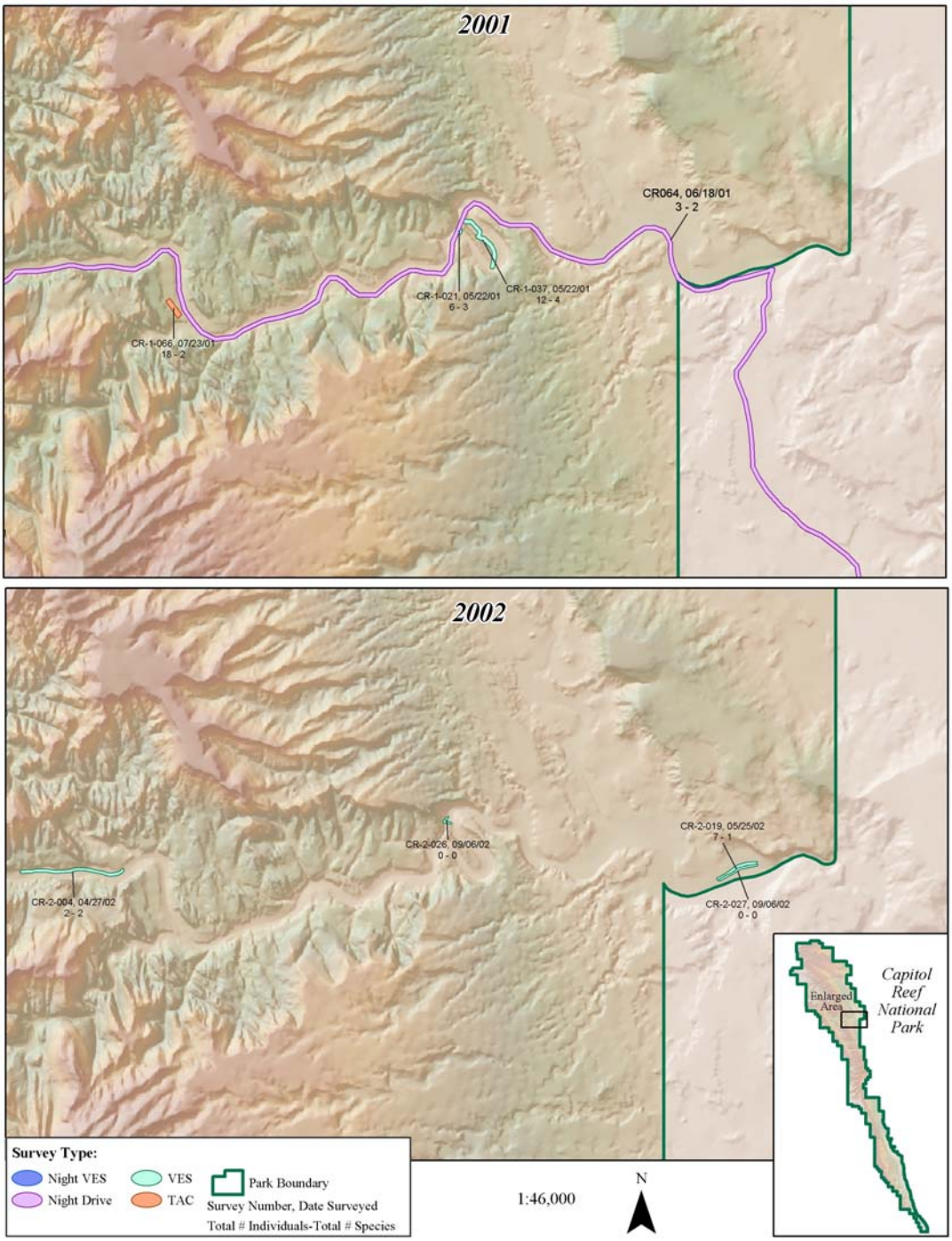

Figure 5f. Herpetofauna inventory effort in Capitol Reef National Park, subsection 5. Line color depicts survey type, width of line shows survey coverage. Lines are labeled with survey number, date, and number of individual observations to number of species observed.

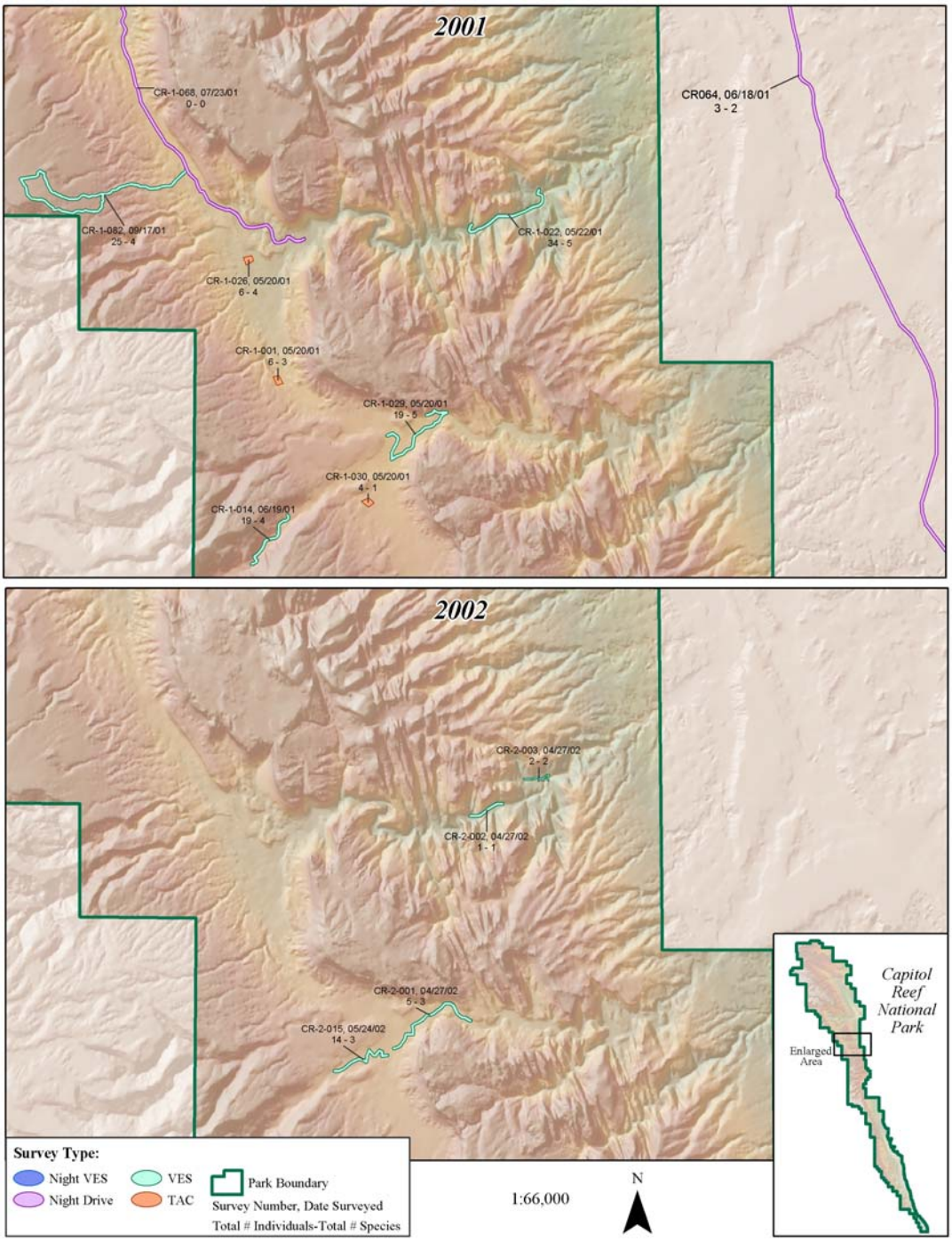

Figure 5g. Herpetofauna inventory effort in Capitol Reef National Park, subsection 6. Line color depicts survey type, width of line shows survey coverage. Lines are labeled with survey number, date, and number of individual observations to number of species observed.

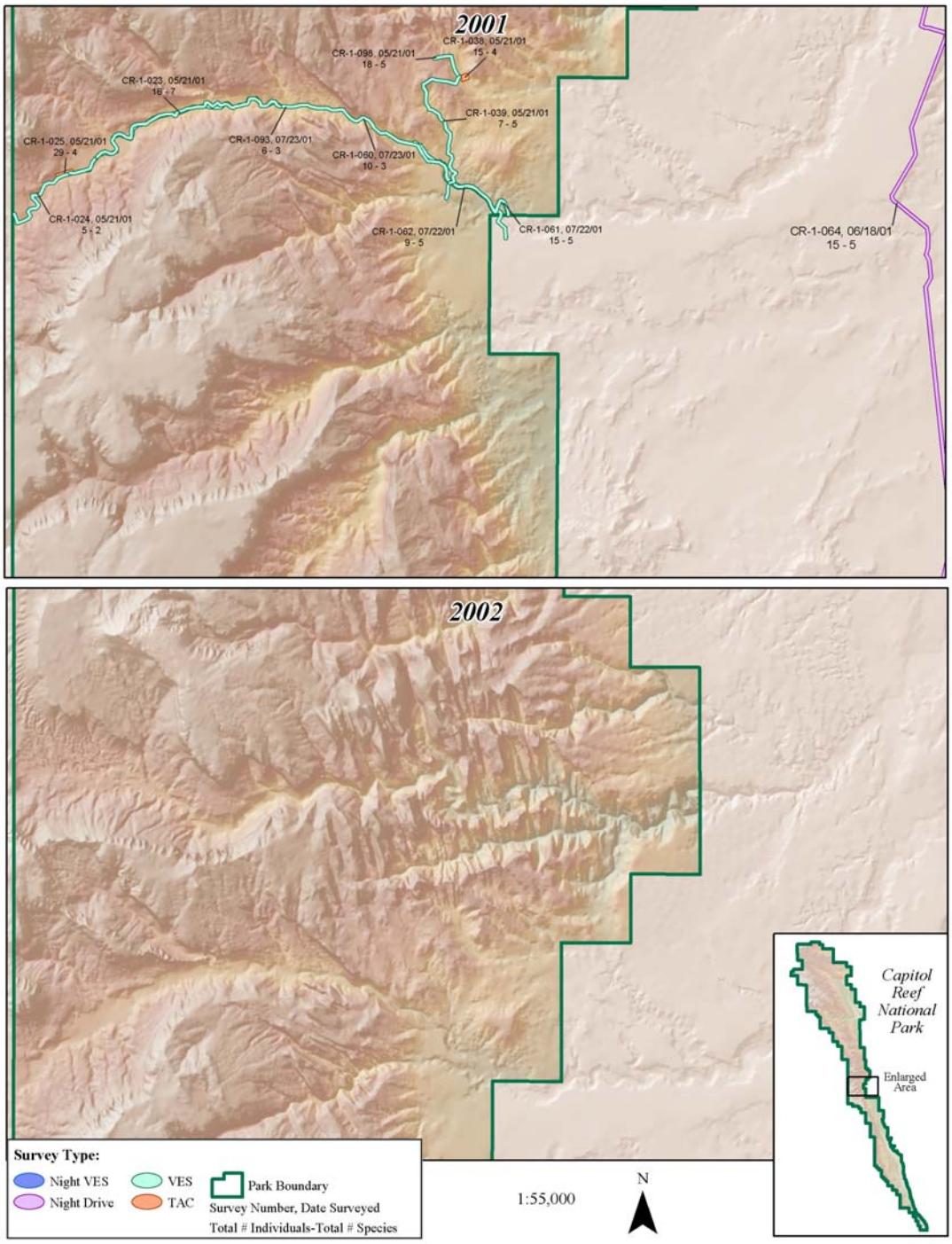

Figure 5h. Herpetofauna inventory effort in Capitol Reef National Park, subsection 7. Line color depicts survey type, width of line shows survey coverage. Lines are labeled with survey number, date, and number of individual observations to number of species observed.

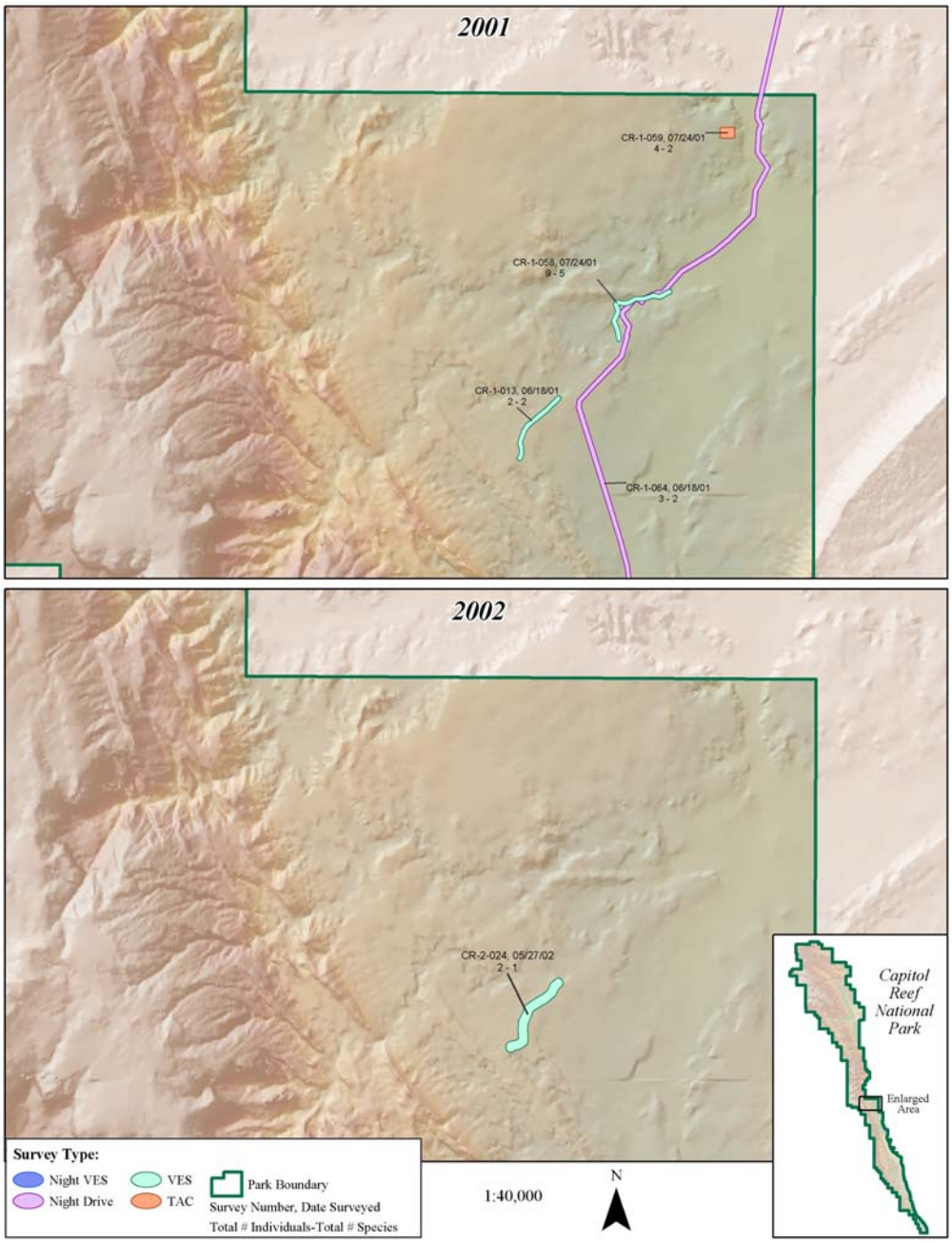

Figure 5i. Herpetofauna inventory effort in Capitol Reef National Park, subsection 8. Line color depicts survey type, width of line shows survey coverage. Lines are labeled with survey number, date, and number of individual observations to number of species observed.

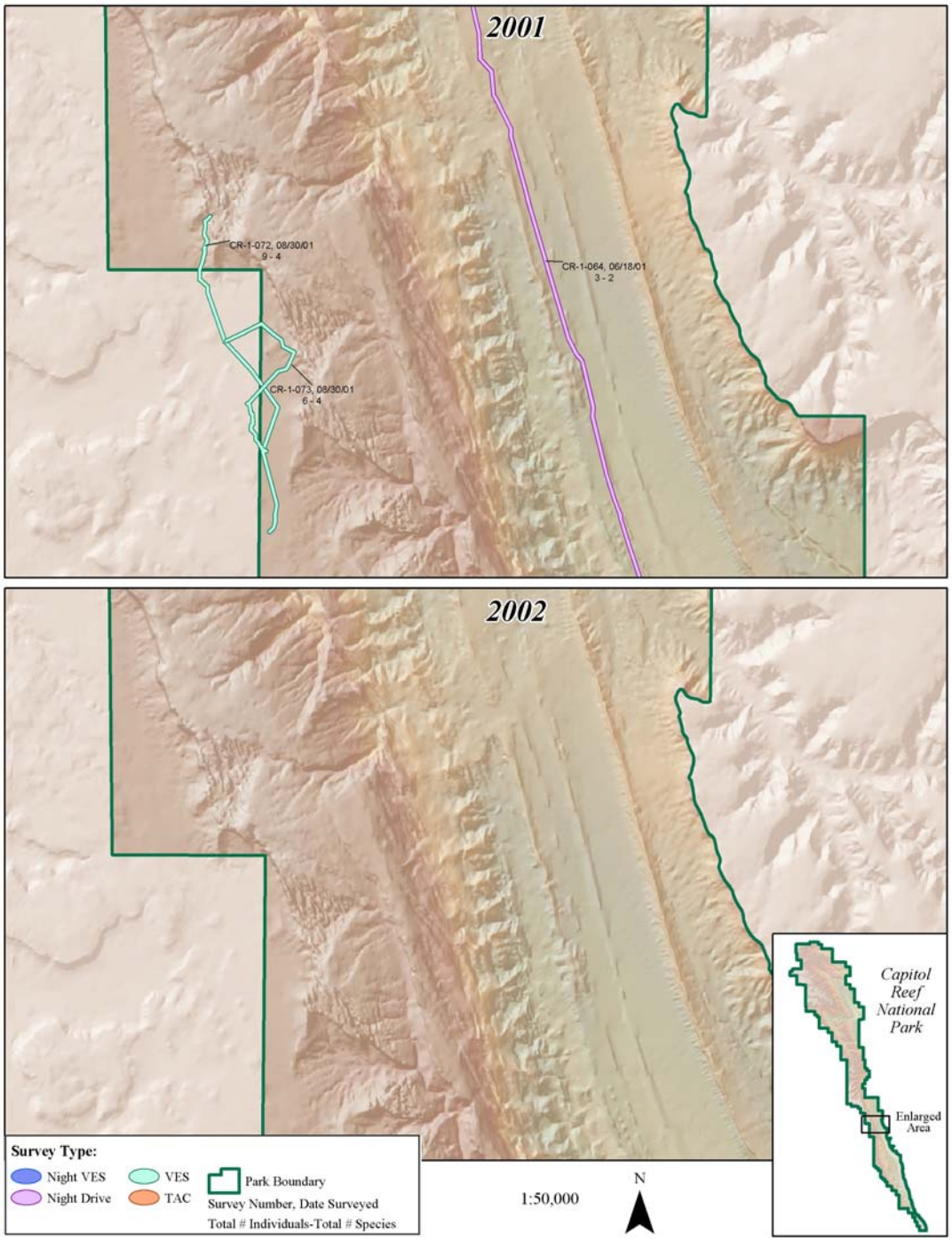

Figure 5j. Herpetofauna inventory effort in Capitol Reef National Park, subsection 9. Line color depicts survey type, width of line shows survey coverage. Lines are labeled with survey number, date, and number of individual observations to number of species observed.

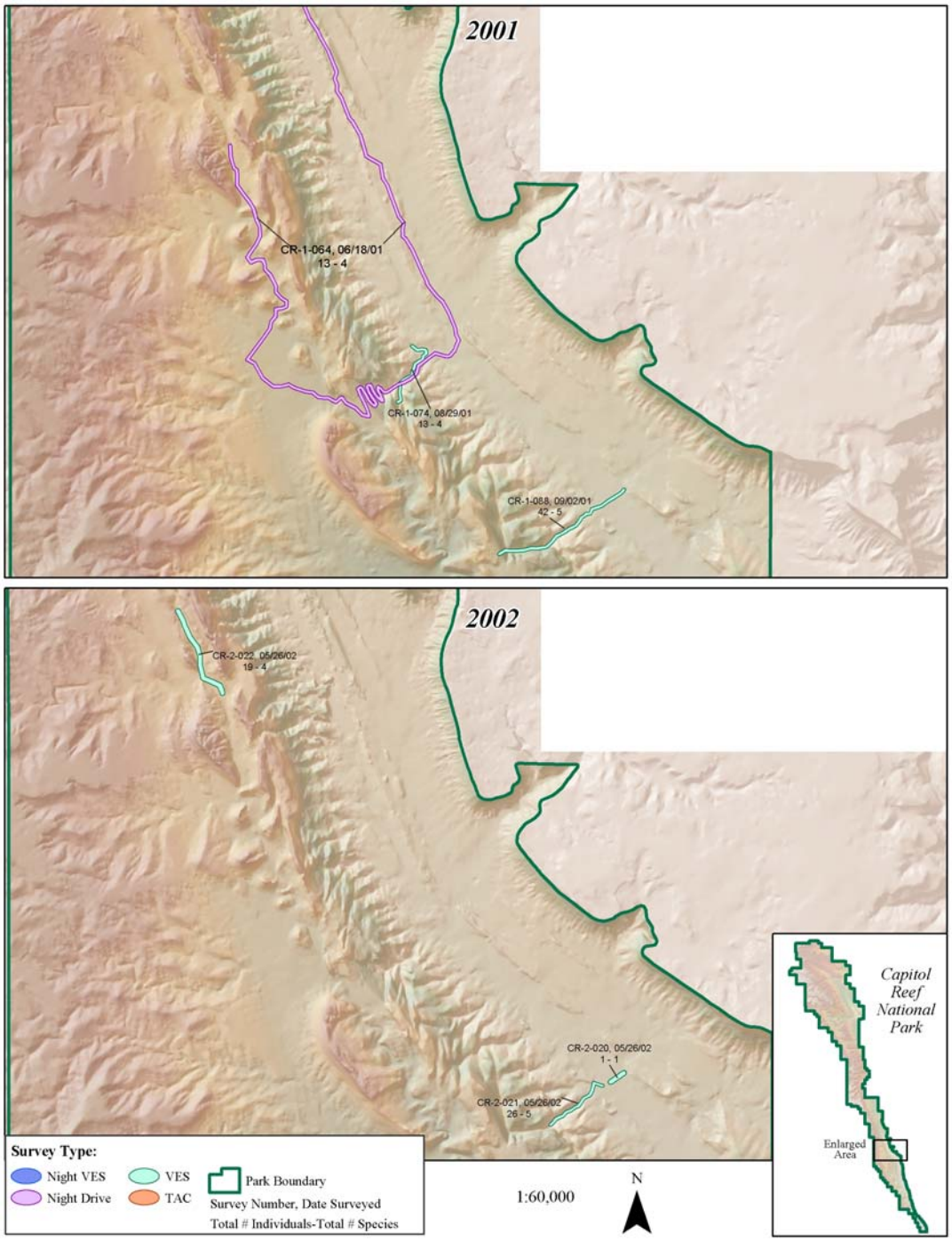

Figure 5k. Herpetofauna inventory effort in Capitol Reef National Park, subsection 10. Line color depicts survey type, width of line shows survey coverage. Lines are labeled with survey number, date, and number of individual observations to number of species observed.

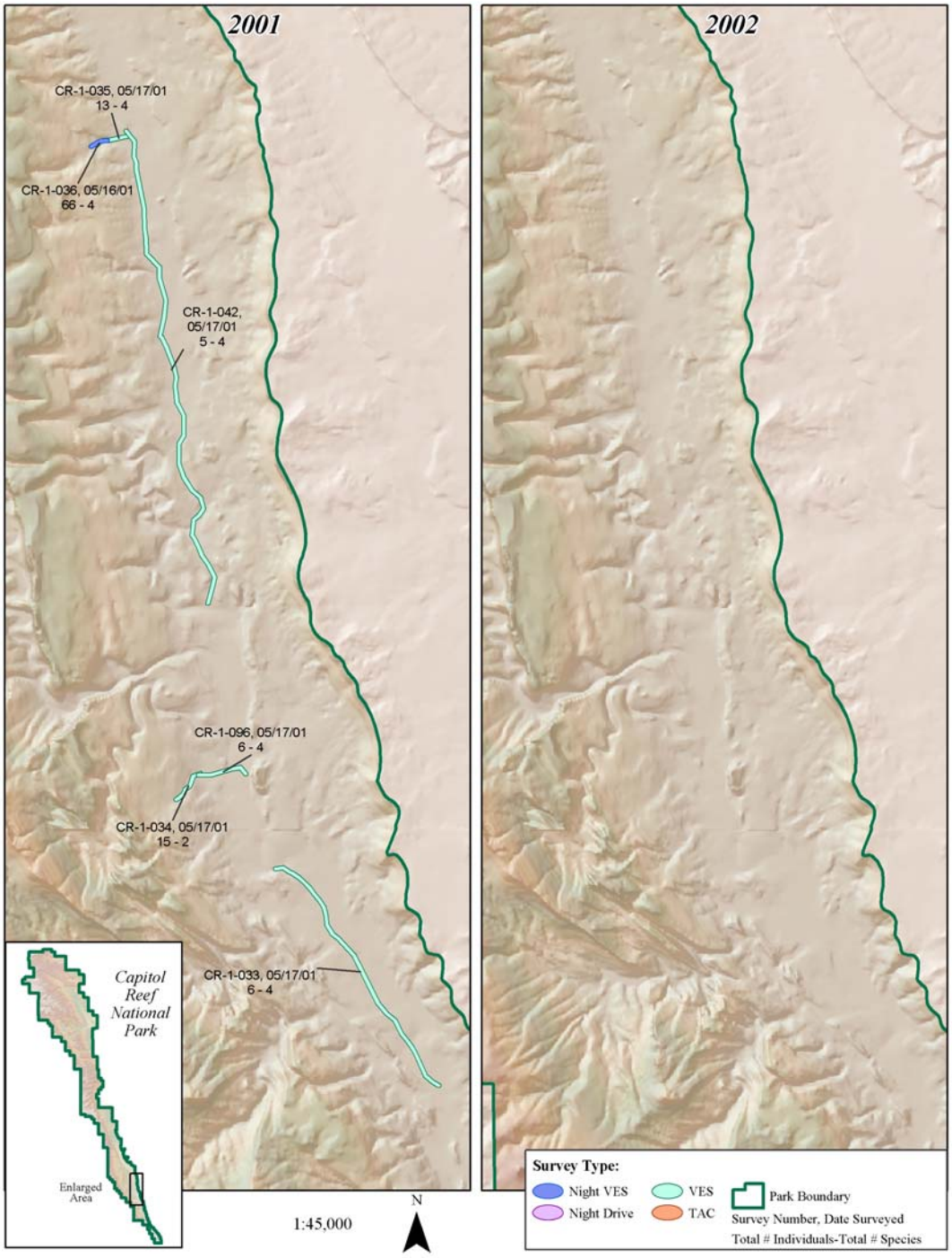

Figure 5l. Herpetofauna inventory effort in Capitol Reef National Park, subsection 11. Line color depicts survey type, width of line shows survey coverage. Lines are labeled with survey number, date, and number of individual observations to number of species observed.

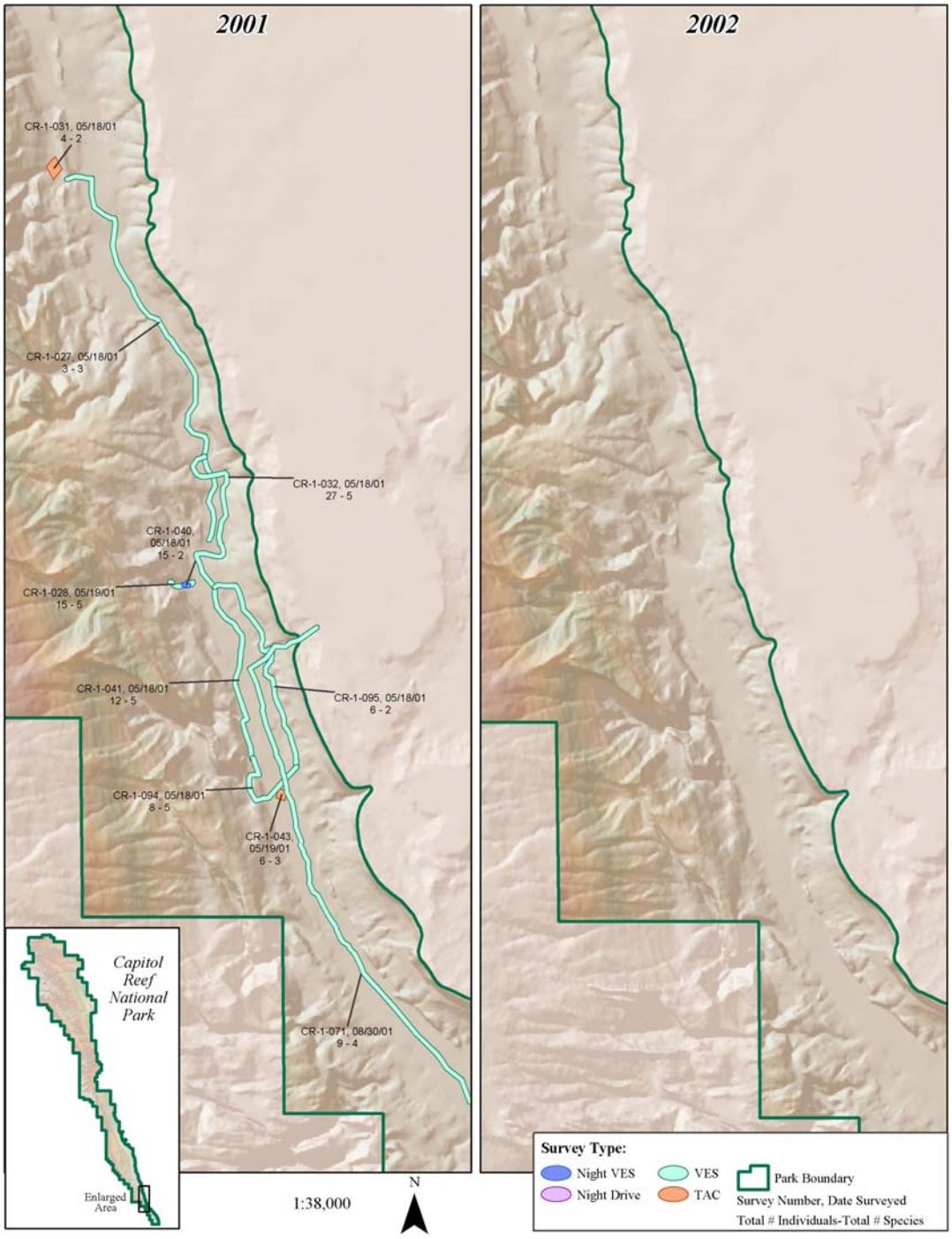

Figure 5m. Herpetofauna inventory effort in Capitol Reef National Park, subsection 12. Line color depicts survey type, width of line shows survey coverage. Lines are labeled with survey number, date, and number of individual observations to number of species observed.

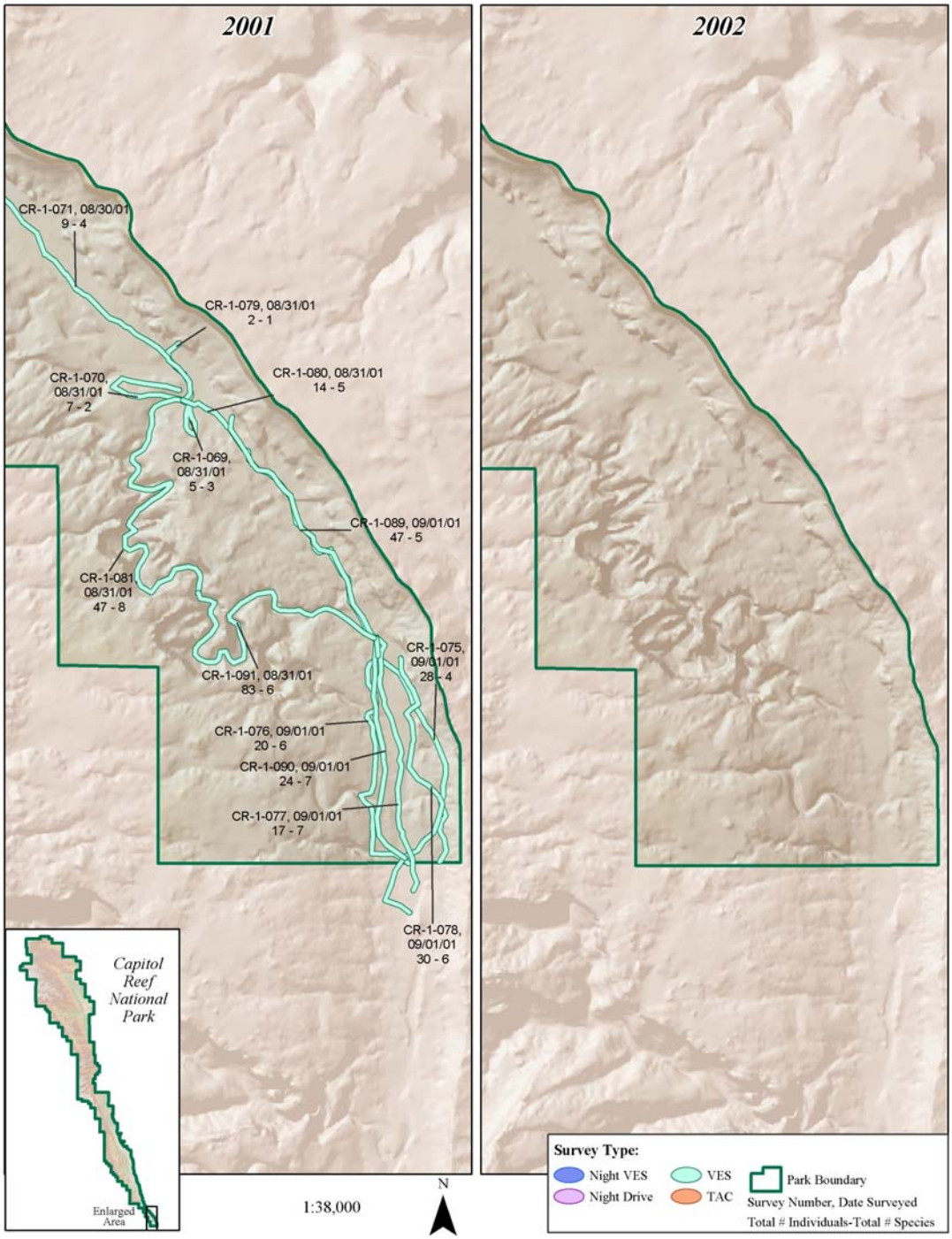

Figure 5n. Herpetofauna inventory effort in Capitol Reef National Park, subsection 13. Line color depicts survey type, width of line shows survey coverage. Lines are labeled with survey number, date, and number of individual observations to number of species observed.

Cedar Breaks National Monument

During 2001 we conducted 20 surveys over three visits to CEBR, of which five were one-hectare TACS. We did not observe any reptiles or amphibians during these surveys.

Survey priorities for 2002 were to locate spring breeding amphibians and any herpetofauna present in the lower elevations of the park unit. We made two field visits; a third visit scheduled for early June had to be cancelled due to a forest fire that had closed the park. We conducted 14 surveys both on the rim and in the lower canyons, and documented one species, the boreal chorus frog (*Pseudacris maculata*), breeding in a pool on the rim (table 3). We counted four individuals of this species. No other herpetofauna was observed, and no specimens were collected from this park unit during 2002.

Figure 6 shows the level of effort expended in person-hours (time multiplied by the number of surveyors) in survey according to habitat type in 2002. Most of survey effort was spent in spruce-fir forest along the rim and in the riparian area of Ashdown and Rattle Creeks in the lower canyons. We found one species in the spruce-fir forest, in a small slump pond on the rim. Figure 7 (a-b) shows survey locations by survey type in CEBR for both 2001 and 2002.

In addition to survey effort, we prepared "Wanted Posters" soliciting observation reports from visitors. These depicted photographs of an assortment of reptile and amphibian species, and requested anyone having seen one to report it to the ranger station or to us directly. As yet, there have been no reports.

Our estimated inventory completeness for CEBR is 100%. There is virtually no existing information on herpetofauna of CEBR, and very little for the surrounding areas. The habitat of the park unit is largely unsuitable for reptiles, and there are few breeding sites for amphibians. It is possible the Alpine Pond could support tiger salamanders (*Ambystoma tigrinum*), although this pond contains Brook Trout that could affect the presence of amphibians. There is a remote chance that rattlesnakes (*Crotalus viridis*), ringneck snakes (*Diadophis punctatus*), sagebrush lizards (*Sceloporus graciosus*), and western skinks (*Eumeces skiltonianus*) may occur in the lower elevations below the rim, but there is no existing evidence for their presence. These species are extremely secretive, with the exception of the sagebrush lizard, and the likelihood of observing any of them is poor. We recommend that any further survey effort at CEBR use pit-fall traps or cover objects to increase survey effort.

Table 3. Amphibian and reptile species observed at CEBR in 2002. An asterisk (*) denotes that a photo voucher was collected for this species. Species in boldface had not been previously documented by the present inventory.

CEDAR BREAKS NATIONAL MONUMENT	
AMPHIBIANS	
***Boreal Chorus Frog**	***Pseudacris maculata***

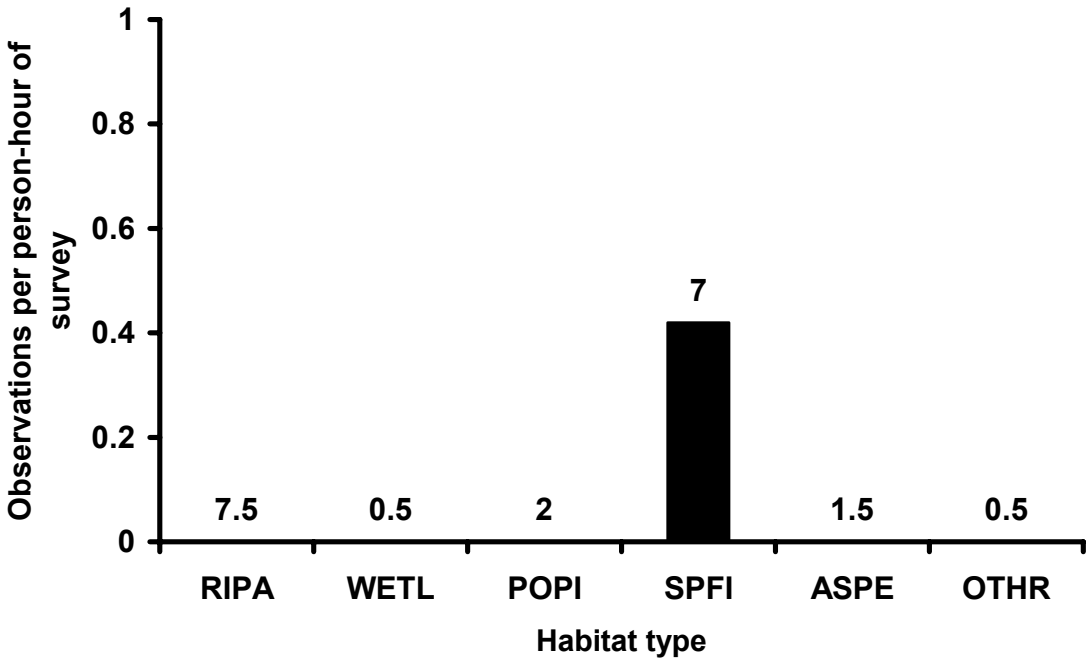

Figure 6. Survey effectiveness among habitat types sampled in CEBR during 2002. **RIPA** = Riparian and canyon woodlands; **WETL** = Wetland; **POPI** = Ponderosa pine woodlands and forest; **SPFI** = Spruce-fir forest; **ASPE** = Aspen forest; **OTHR** = Other habitat types. Numbers appearing over bars denote number of person-hours of survey expended in each habitat type.

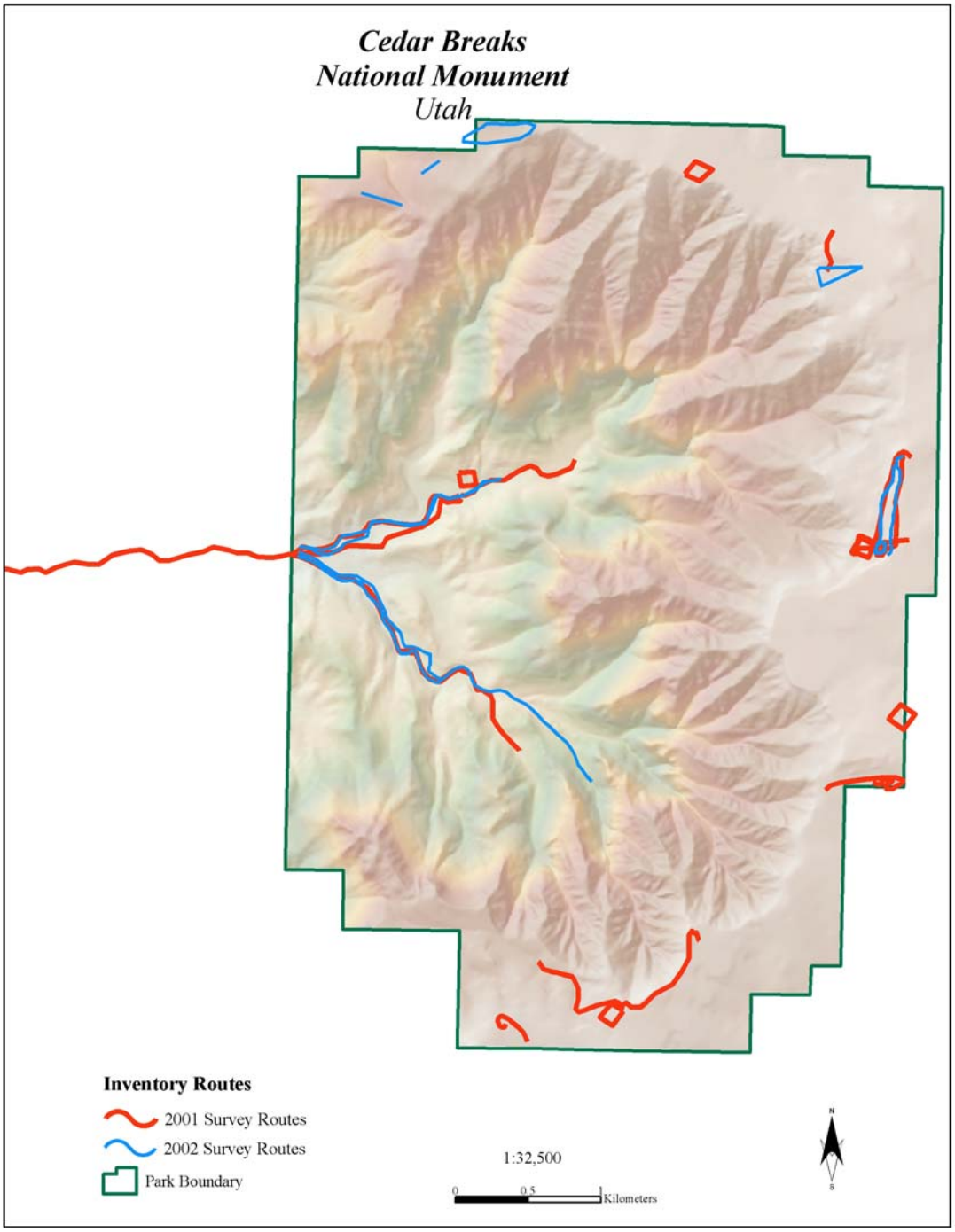

Figure 7a. Herpetofauna inventory effort in Cedar Breaks National Monument in 2001 and 2002.

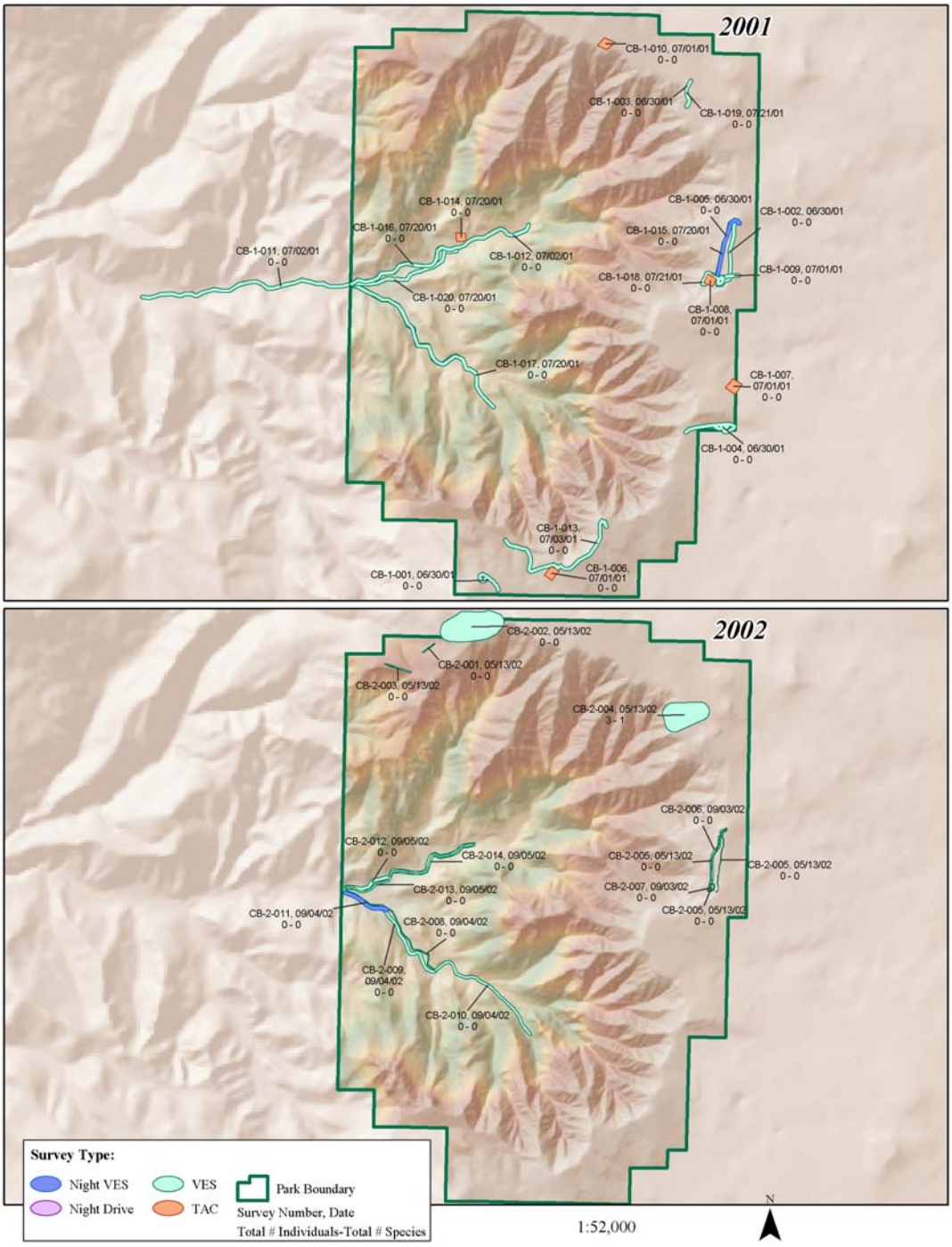

Figure 7b. Herpetofauna inventory effort in Cedar Breaks National Monument. Line color depicts survey type, width of line shows survey coverage. Lines are labeled with survey number, date, and number of individual observations to number of species observed.

Fossil Butte National Monument

During 2001 we conducted 25 surveys over three visits to FOBU, all of which were diurnal VES. We documented two amphibians, one lizard and one snake species (table 4) from a total of 26 observations. Figure 8 (a–c) shows survey locations by survey type in FOBU for both 2001 and 2002.

Survey priorities in 2002 were to locate spring breeding amphibians that were known to occur in the locality. We conducted 5 surveys, including two nighttime surveys of the wetlands in Chicken Creek and the West Dam site, during one visit in mid-April. We documented our target species, the boreal chorus frog (*Pseudacris maculata*), although no other species were observed. We made five observations of this species, and only surveyed in one habitat type, concentrating in small wetland areas within Great Basin sagebrush. No specimens were collected from this park unit during this inventory.

We estimate our inventory completeness at this park unit as 100%, based on previous documentation (Dorn et al, 1984; Rado, 1977), park observation records, and regional species distribution maps (Baxter & Stone, 1985; Wyoming Game and Fish Department, 1999). The sagebrush lizard (*Sceloporus graciosus*) might potentially occur in the area, and FOBU falls within the distribution range and habitat type for this species, but it is not known to be present. It should, however, be added to a watch list as a potential species.

Table 4. Amphibian and reptile species observed at FOBU in 2001 and 2002. An asterisk (*) denotes that a photo voucher has been collected for this species. Species in boldface had not been previously documented by the present inventory, species followed by a (‡) were observed only in 2001.

FOSSIL BUTTE NATIONAL MONUMENT	
AMPHIBIANS	
*Tiger Salamander‡	*Ambystoma tigrinum*
***Boreal Chorus Frog**	***Pseudacris maculata***
*Northern Leopard Frog‡	*Rana pipiens*
LIZARDS	
*Mountain Short Horned Lizard‡	*Phrynosoma hernandesi*
SNAKES	
*Wandering Garter Snake‡	*Thamnophis elegans vagrans*

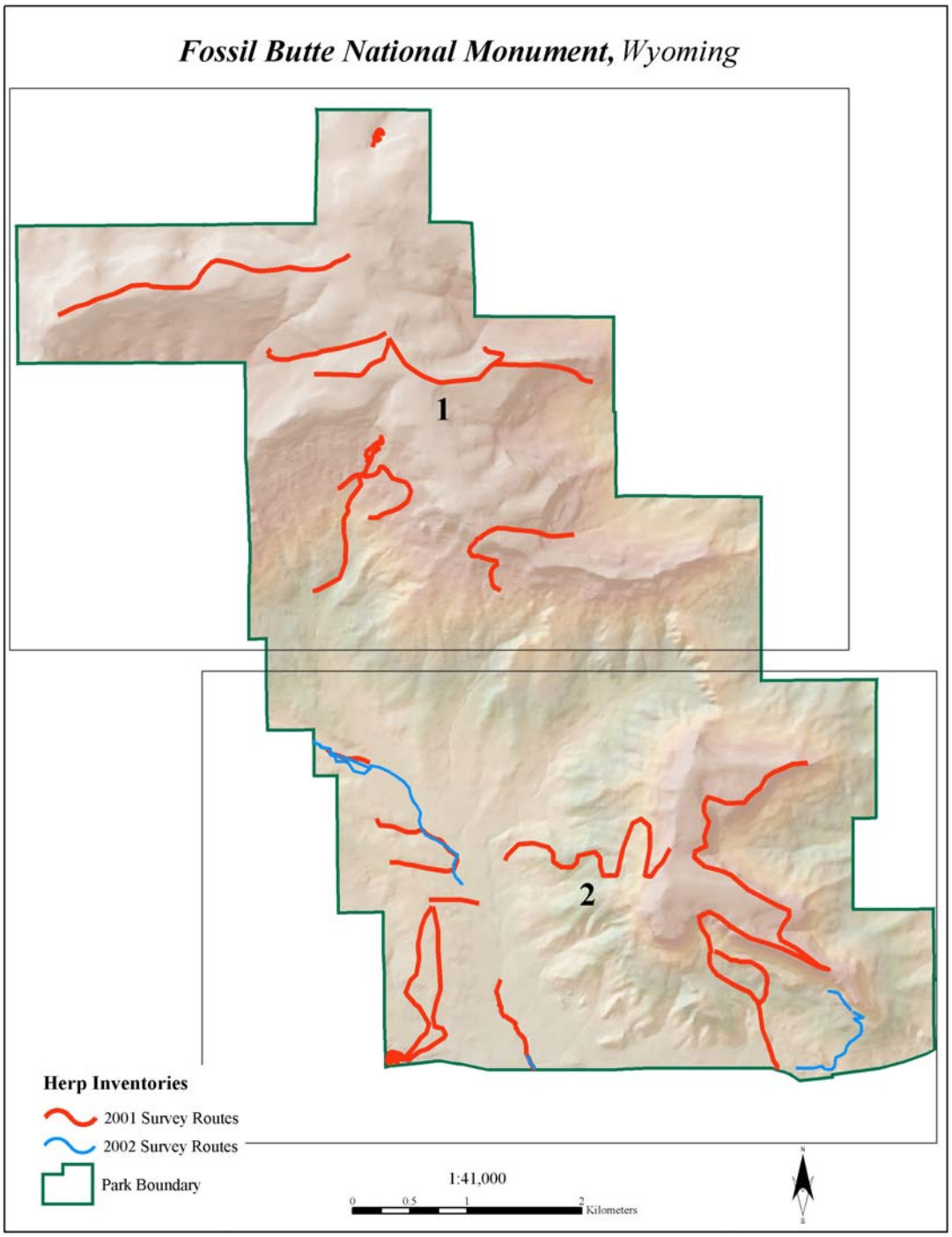

Figure 8a. Herpetofauna inventory effort in Fossil Butte National Monument in 2001 and 2002. Numbered insets refer to subsequent maps detailing survey information.

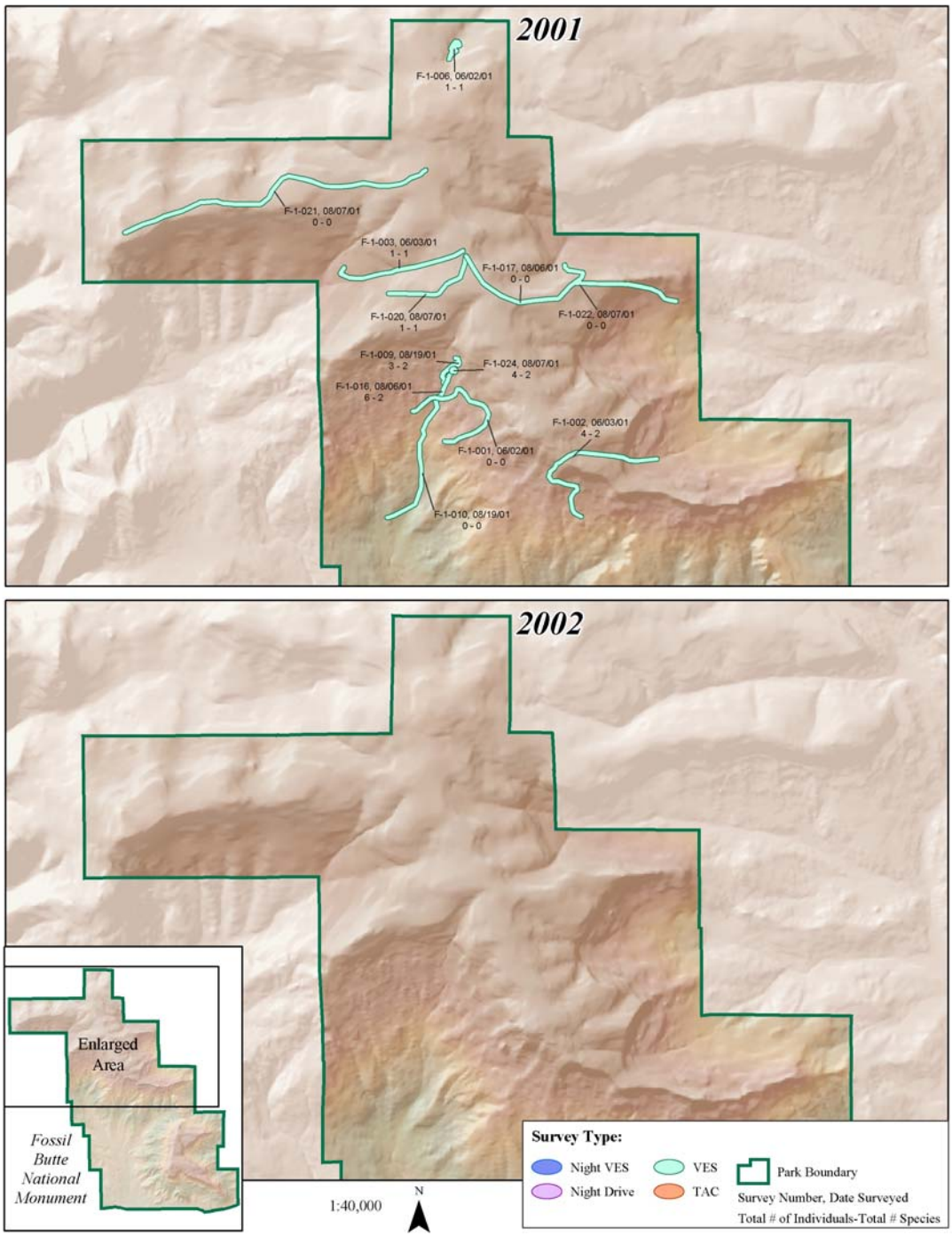

Figure 8b. Herpetofauna inventory effort in Fossil Butte National Monument, subsection 1. Line color depicts survey type, width of line shows survey coverage. Lines are labeled with survey number, date, and number of individual observations to number of species observed.

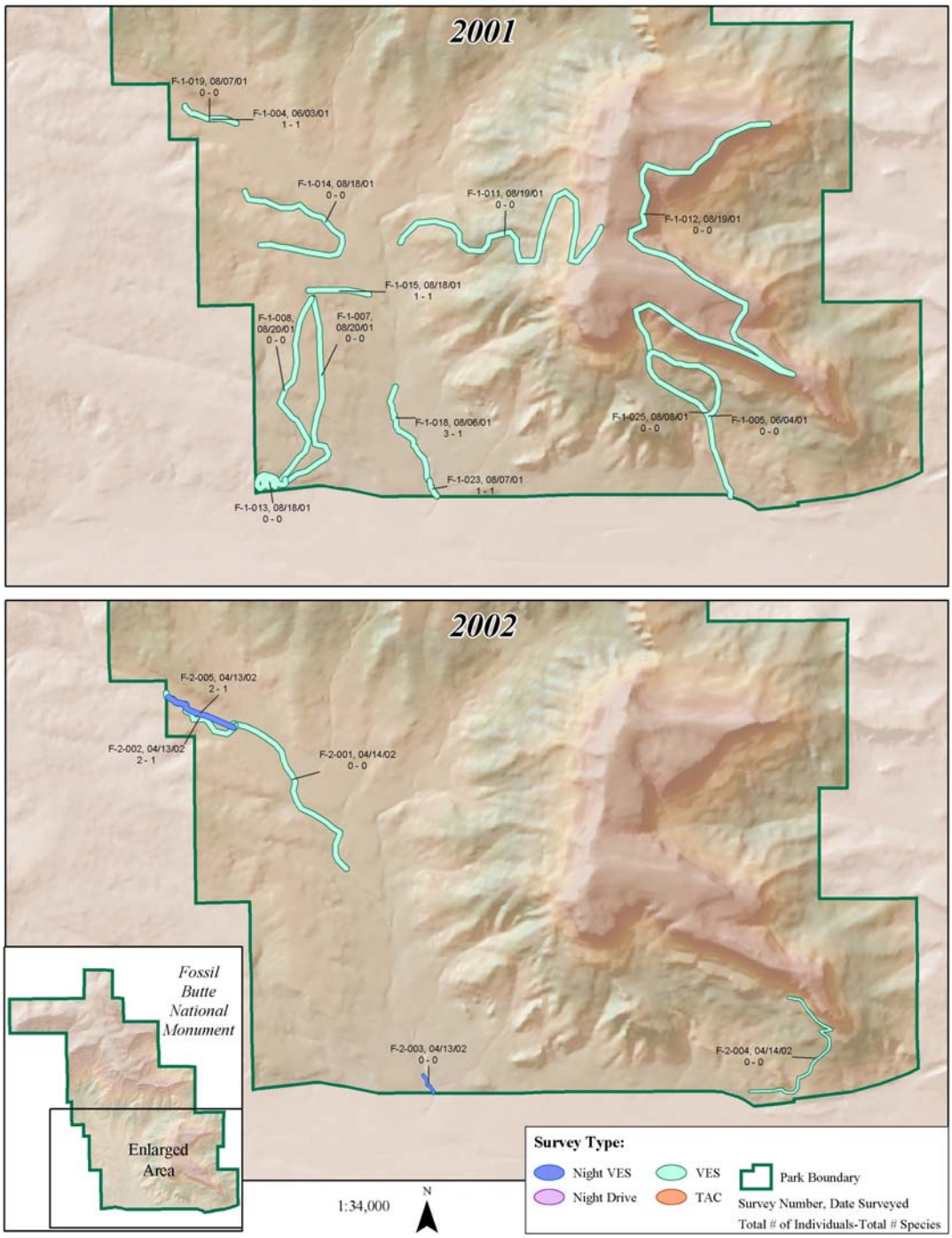

Figure 8c. Herpetofauna inventory effort in Fossil Butte National Monument, subsection 2. Line color depicts survey type, width of line shows survey coverage. Lines are labeled with survey number, date, and number of individual observations to number of species observed.

Golden Spike National Historic Site

During 2001 we conducted 21 surveys over three visits to GOSP, five of which were one-hectare TACS. We documented four amphibian, three lizard and four snake species (table 5) from a total of 36 observations.

Survey priorities during 2002 were to locate spring breeding amphibians and lizards. We conducted 19 surveys, during two field visits, including 3 night drives and one nighttime wetlands survey, and made 11 individual observations. No new species from last year were observed during the field surveys, but we documented two new lizard species: the western skink (*Eumeces skiltonianus*) and the desert horned lizard (*Phrynosoma platyrhinos*). We took possession of two specimens collected by Rick Wilson, head ranger, the skink and a western rattlesnake (*Crotalus viridis*). The skink is an unusual occurrence for that area, and was captured in a mousetrap in the ranger's residence. A racer (*Coluber constrictor*) road-kill was also salvaged. Documentation for the horned lizard was provided by the head ranger and the NCPN I & M Mammal Survey Crew.

Figure 9 shows the level of effort expended in person-hours (time multiplied by the number of surveyors) in survey according to habitat type in 2002. Most of survey effort was spent in Great Basin sagebrush habitat, the dominant habitat type at GOSP, but most of our findings in 2002 were around the ranger's residence, visitors center, and on the road (placed into the "other" habitat category). Figure 10 (a-c) shows survey locations by survey type in GOSP for both 2001 and 2002.

Our estimated inventory completeness for GOSP is 93%, based on habitat structure, range distribution maps, and park observation records. There is one species likely to occur in the park that we were unable to document during this inventory, the boreal chorus frog (*Pseudacris maculata*). This species was observed nearby in 2002 (D. Mulcahy, pers. comm.), and it is possible it also occurs within the park itself. Two snakes should be added to a watch list for this park, the common garter snake (*Thamnophis sirtalis*) and the western terrestrial garter snake (*Thamnophis elegans*). The park falls within the distribution range for these species (Stebbins, 1985), although they are not known from the area.

Table 5. Amphibian and reptile species observed at GOSP in 2001 and 2002. An asterisk (*) denotes that a photo voucher has been collected for this species. Species in boldface had not been previously documented by the present inventory, species followed by a (‡) were observed only in 2001.

GOLDEN SPIKE NATIONAL HISTORIC SITE	
AMPHIBIANS	
*Tiger Salamander‡	*Ambystoma tigrinum*
*Woodhouse's Toad‡	*Bufo woodhousii*
Northern Leopard Frog‡	*Rana pipiens*
*Great Basin Spadefoot	*Spea intermontana*
LIZARDS	
*Western Whiptail‡	*Cnemidophorus tigris*
Sagebrush Lizard‡	*Sceloporus graciosus*
Side-blotched Lizard	*Uta stansburiana*
Western Skink	*Eumeces skiltonianus*
Desert Horned Lizard **(digital photo provided by park personnel)**	***Phrynosoma platyrhinos***
SNAKES	
*Yellow-bellied Racer	*Coluber constrictor mormon*
*Great Basin Rattlesnake	*Crotalus viridis lutosus*
Striped Whipsnake‡	*Masticophis taeniatus*
Gopher Snake‡	*Pituophis catenifer*

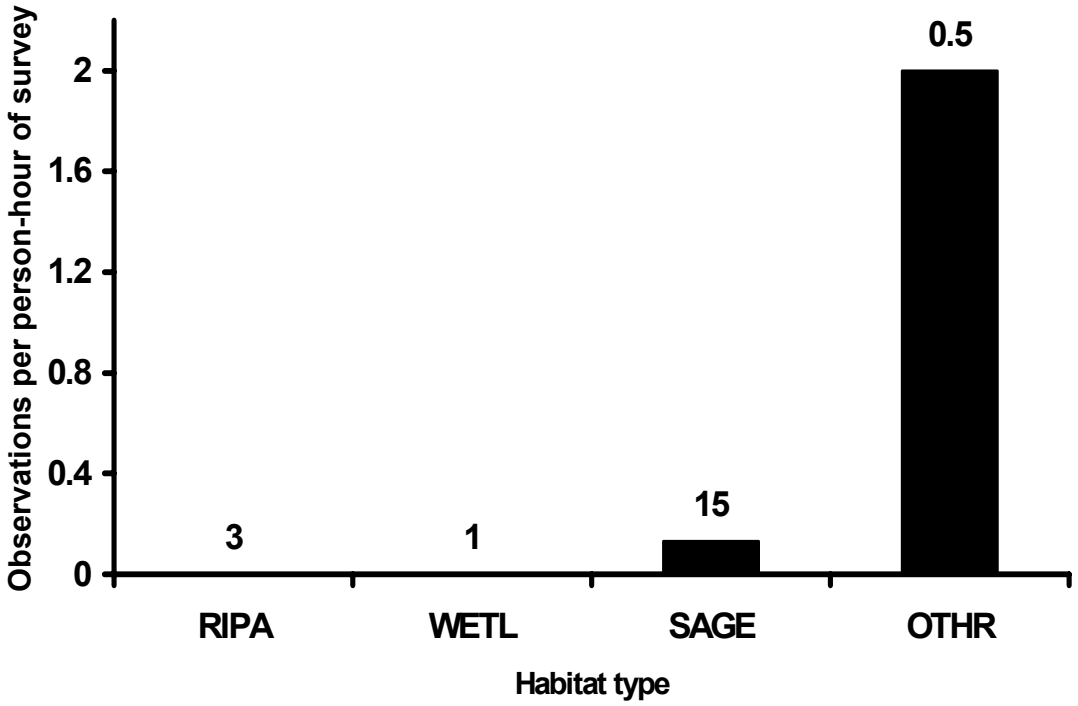

Figure 9. Survey effectiveness among habitat types sampled in GOSP during 2002. **RIPA** = Riparian and canyon woodlands; **WETL** = Wetland; **SAGE** = Great Basin sagebrush; **OTHR** = Other habitat types. Numbers appearing over bars denote number of person-hours of survey expended in each habitat type.

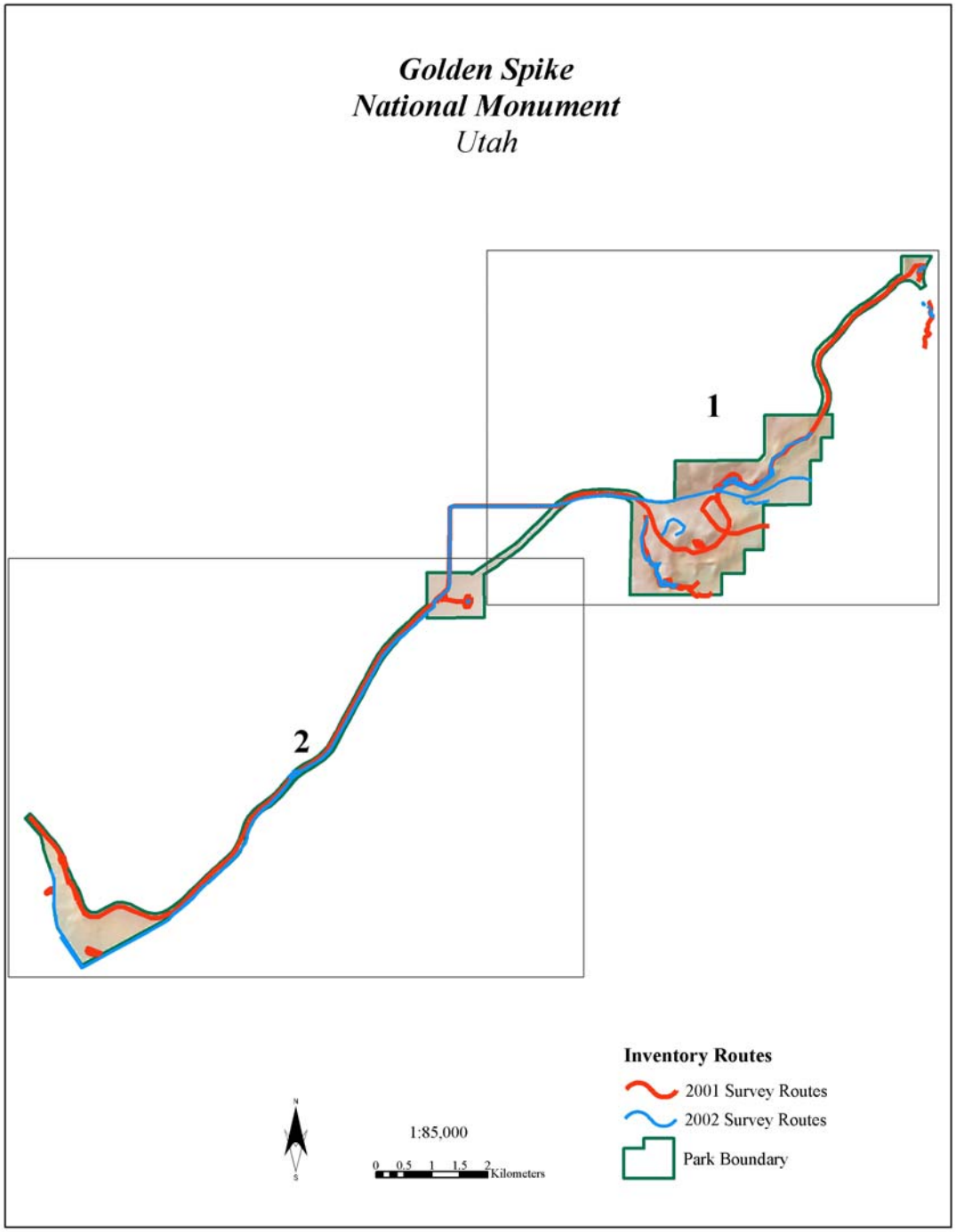

Figure 10a. Herpetofauna inventory effort in Golden Spike National Historic Site in 2001 and 2002. Numbered insets refer to subsequent maps detailing survey information.

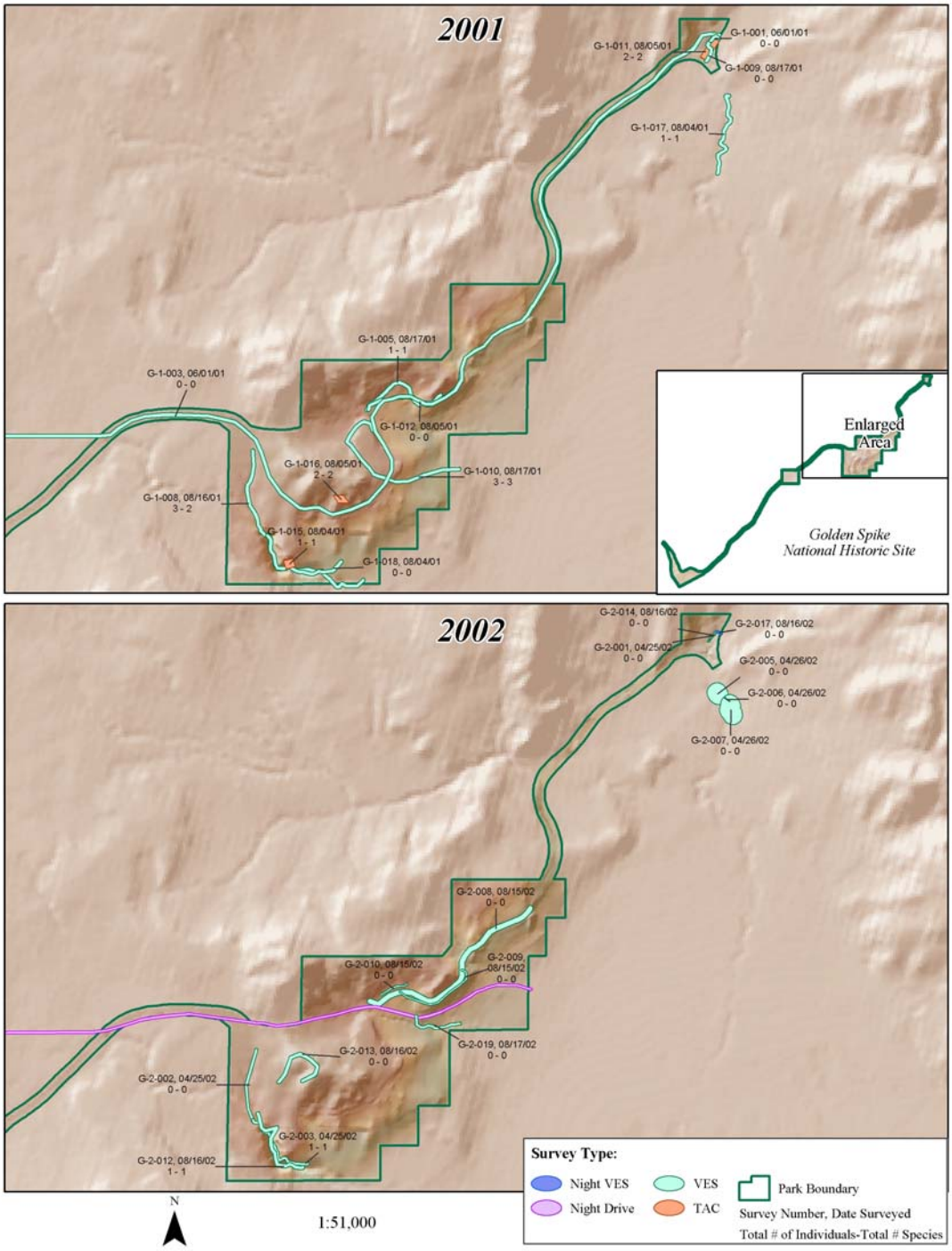

Figure 10b. Herpetofauna inventory effort in Golden Spike National Historic Site, subsection 1. Line color depicts survey type, width of line shows survey coverage. Lines are labeled with survey number, date, and number of individual observations to number of species observed.

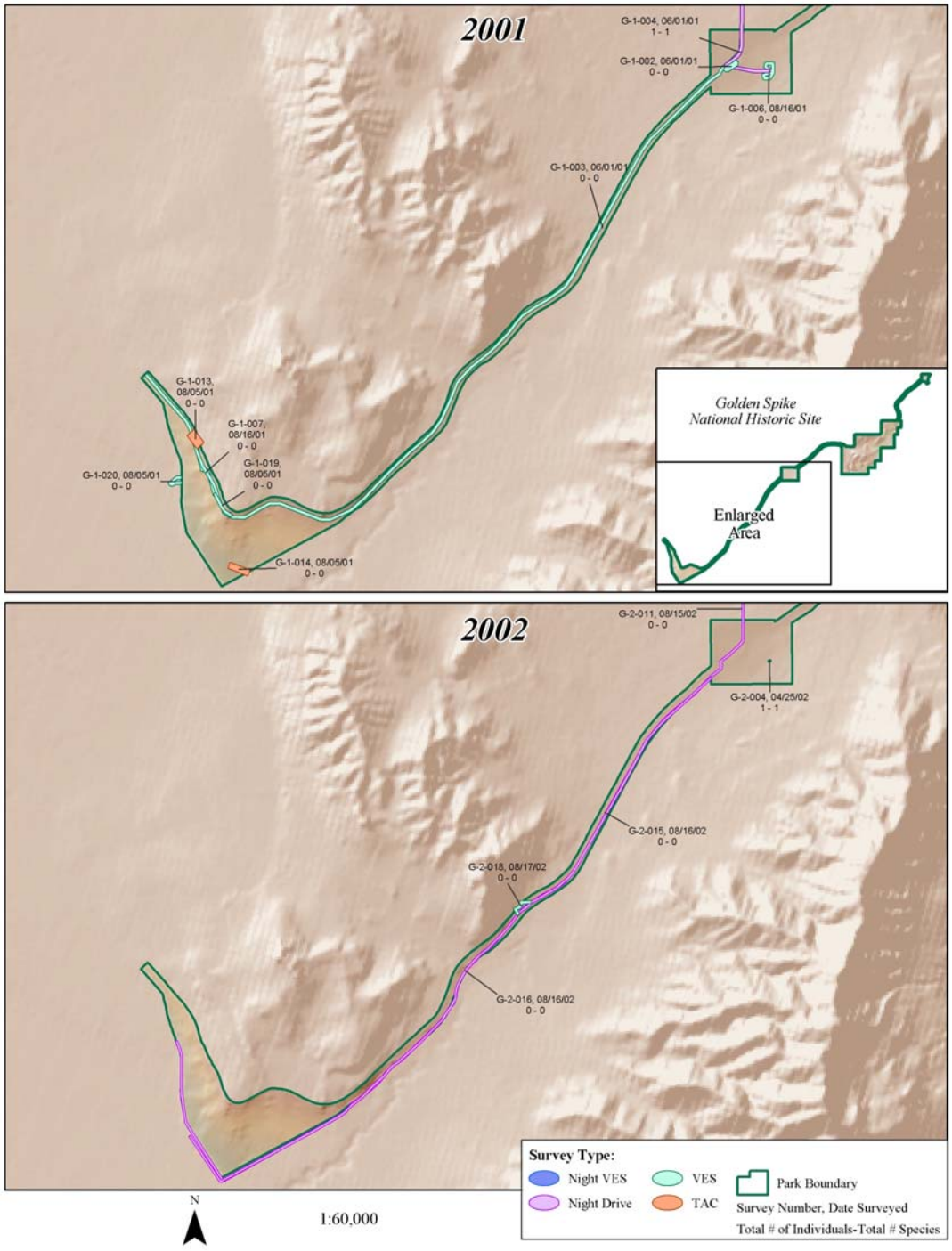

Figure 10c. Herpetofauna inventory effort in Golden Spike National Historic Site, subsection 2. Line color depicts survey type, width of line shows survey coverage. Lines are labeled with survey number, date, and number of individual observations to number of species observed.

Pipe Spring National Monument

During 2001 we conducted 19 surveys over three visits to PISP, two of which were nighttime surveys. The entire park unit was surveyed on each of the three visits. We documented three amphibian, eight lizard and three snake species (table 6) from a total of 124 observations. The presence of the Woodhouse's toad was confirmed through photographs taken by the monument staff.

Survey priorities in 2002 were to locate breeding amphibians and snakes not already documented. We conducted 26 surveys, including 4 nighttime surveys, over two field visits and made 82 individual observations. We did not observe any species not already documented in 2001, but we did capture and photograph neotenic salamanders (*Ambystoma tigrinum*) from the ponds. No specimens were collected from this park unit.

Figure 11 shows the level of effort expended in person-hours (time multiplied by the number of surveyors) in survey according to habitat type in 2002. Most of survey effort was spent in salt desert scrub, the dominant habitat type at PISP, although many of our sightings were in the ponds (artificial habitat) or around the residence and maintenance areas (categorized as "other" habitat type). Figure 12 shows survey locations by survey type in PISP for both 2001 and 2002. Inventory effort included multiple coverage of the entire park unit, consisting of 16 hectares.

Our estimated inventory completeness for PISP is 82%. We estimate that there are two species that remain undocumented under this inventory: common kingsnake (*Lampropeltis getula*), and western terrestrial garter snake (*Thamnophis elegans*). Both species have been documented by the monument staff in previous years. Although we expected the tree lizard (*Urosaurus ornatus*) to be present in PISP, this species is not known from the region (H. Koenig, pers. comm.). Although the distribution of the western skink (*Eumeces skiltonianus*), longnose snake (*Rhinocheilus lecontei*) and western patchnose snake (*Salvadora hexalepis*) encompasses this region, the habitat is not particularly suitable and they are not known to occur here (T. Duck, pers. comm.). Other species for which there is no existing information, but which could reasonably expected to occur in PISP and should therefore be placed on a watch list, are: red-spotted toad (*Bufo punctatus*), canyon treefrog (*Hyla arenicolor*), and plateau striped whiptail (*Cnemidophorus velox*).

Table 6. Amphibian and reptile species observed at PISP in 2001 and 2002. An asterisk (*) denotes that a photo voucher has been collected for this species. Species in boldface had not been previously documented by the present inventory, species followed by a (‡) were observed only in 2001.

PIPE SPRING NATIONAL MONUMENT	
AMPHIBIANS	
*Tiger Salamander	*Ambystoma tigrinum*
Woodhouse's Toad‡	*Bufo woodhousii*
*Great Basin Spadefoot‡	*Spea intermontana*
LIZARDS	
*Western Whiptail	*Cnemidophorus tigris*
*Great Basin Collared Lizard	*Crotaphytus bicinctores*
*Longnose Leopard Lizard	*Gambelia wislizenii*
*Mountain Short Horned Lizard‡	*Phrynosoma hernandesi*
Sagebrush Lizard	*Sceloporus graciosus*
Desert Spiny Lizard	*Sceloporus magister*
Eastern Fence Lizard	*Sceloporus undulatus*
*Side-blotched Lizard	*Uta stansburiana*
SNAKES	
*Great Basin Rattlesnake	*Crotalus viridis lutosus*
Striped Whipsnake‡	*Masticophis taeniatus*
Gopher Snake	*Pituophis catenifer*

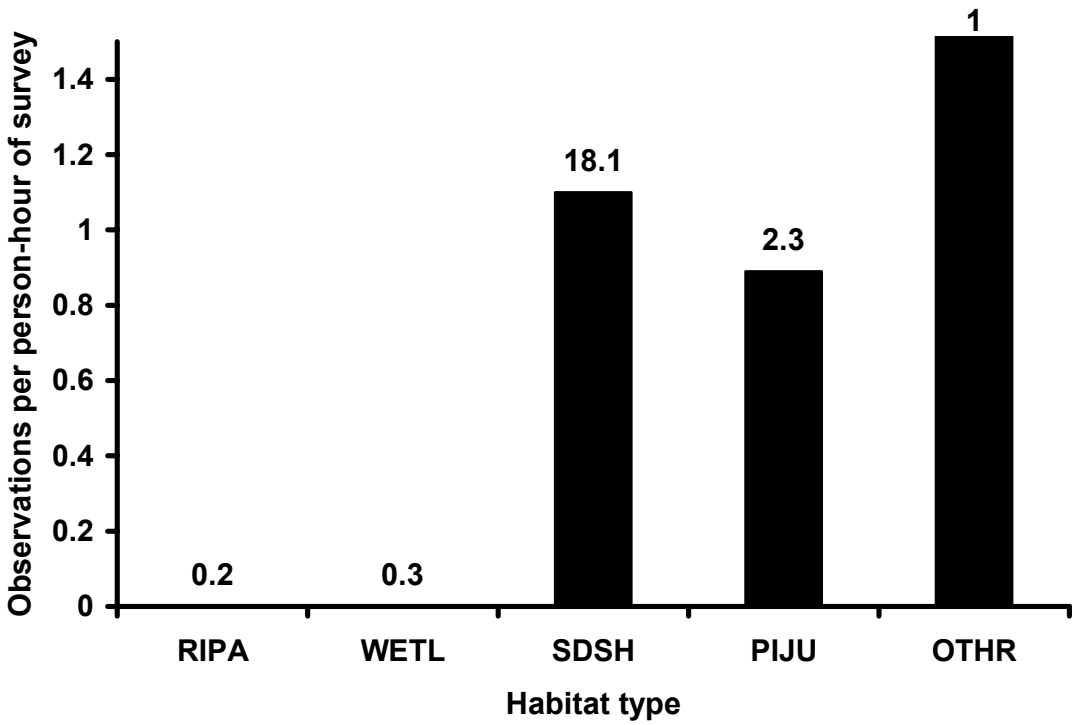

Figure 11. Survey effectiveness among habitat types sampled in PISP during 2002. **RIPA** = Riparian and canyon woodlands; **WETL** = Wetland; **SDSH** = Salt desert scrub; **PIJU** = Pinyon-juniper woodlands; **OTHR** = Other habitat types. Numbers appearing over bars denote number of person-hours of survey expended in each habitat type.

Pipe Spring National Monument, Arizona

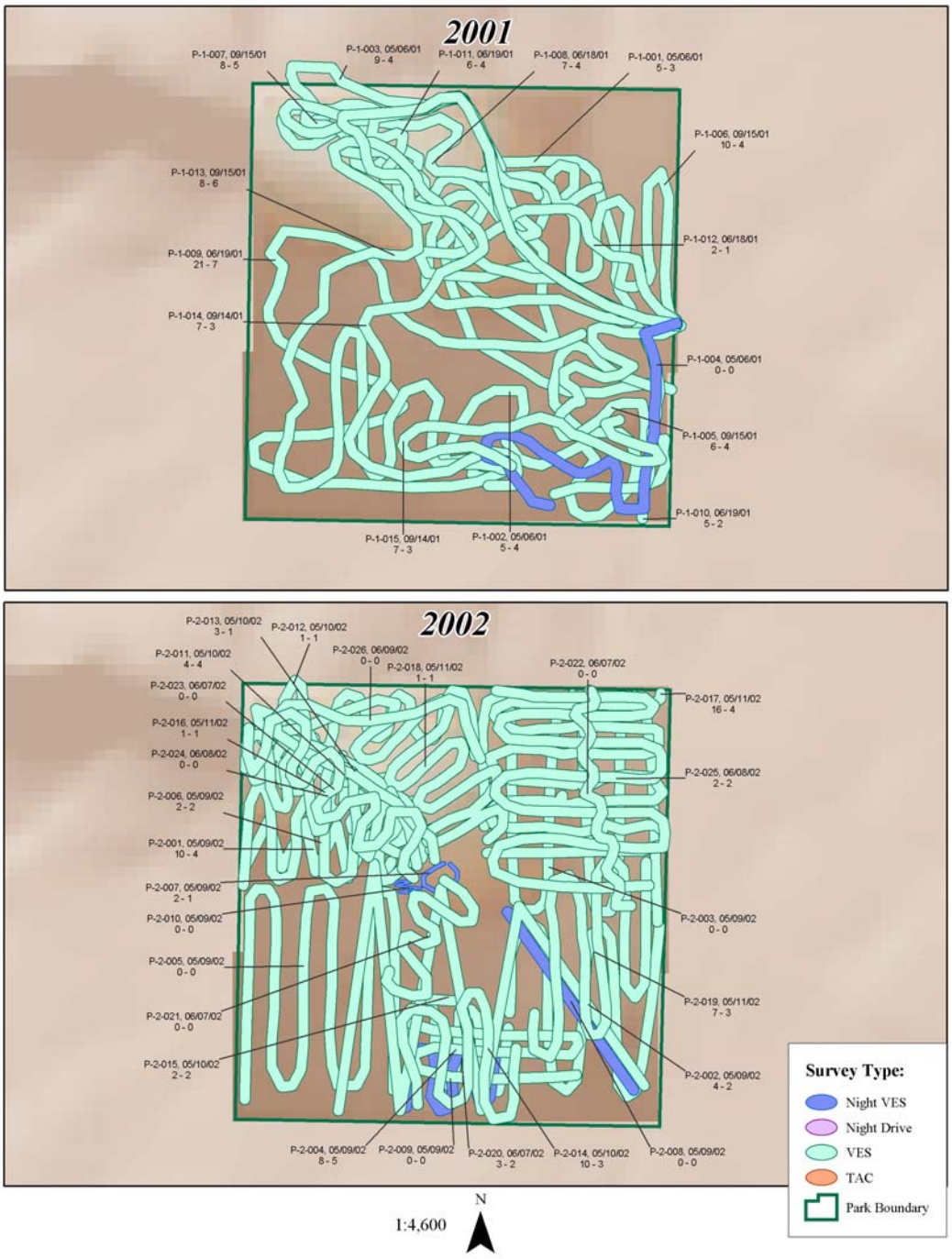

Figure 12. Herpetofauna inventory effort in Pipe Spring National Monument in 2001 and 2002. Line color depicts survey type, width of line shows survey coverage. Lines are labeled with survey number, date and number of individual observations to number of species observed.

Timpanogos Cave National Monument

During 2001 we conducted 16 surveys over three visits to TICA, all of which were general VES. We documented one lizard and three snake species (table 7) from a total of 36 observations. One voucher specimen was collected from TICA during this inventory, a road-killed rubber boa (*Charina bottae*).

Survey priorities in 2002 were to locate amphibians and lizard species not already documented. We made two field visits, and conducted 17 surveys, including 4 nighttime wetland surveys. Only two species were observed in 2002: the sagebrush lizard (*Sceloporus graciosus*) and the western rattlesnake (*Crotalus viridis*), and only one individual of each.

Figure 13 shows the level of effort expended in person-hours (time multiplied by the number of surveyors) in survey according to habitat type in 2002. Most of survey effort was spent in spruce-fir forest, the dominant habitat type at TICA, and in riparian areas. Figure 14 (a-b) shows survey locations by survey type in TICA for both 2001 and 2002, including locations outside of the monument boundaries that we surveyed for breeding amphibians.

Our estimated inventory completeness for TICA is 100%, based on the habitat suitability for herpetofauna. However, there are some voucher specimens for the monument that are not contained on our species list. The monument has a tiger salamander (*Ambystoma tigrinum*) specimen collected from around the ranger's residence in August 1975. The NPSpecies database lists a garter snake (*Thamnophis elegans*), also collected from the residence (date and collector unknown). This specimen was not examined for verification of identification. Although it is likely that salamanders and garter snakes occur in the area, the riparian habitat within the monument is not suitable for these species. It is highly improbable that they are resident to the monument, due to lack of prey items and unsuitability of habitat. Both specimens were probably migrating individuals. The NPSpecies database also contains a record for a night snake (*Hypsiglena torquata*) also collected at the residence (date and collector unknown); although this specimen was not examined it is likely to be a juvenile gopher snake (*Pituophis catenifer*), which look similar to night snakes. Additionally, there is an account of a collared lizard having been observed in the monument (M. Gosse, pers. comm.). The habitat is unsuitable for this species, being shaded for much of the time and with only a short summer season; this species is extremely thermophilic. TICA is close to the urban Salt Lake City area, and is a popular weekend destination. The most likely explanation for the presence of a collared lizard at TICA was that it was brought there from another location and released, a fairly common occurrence among a variety of species in parklands.

Table 7. Amphibian and reptile species observed at TICA in 2001 and 2002. An asterisk (*) denotes that a photo voucher has been collected for this species. Species in boldface had not been previously documented by the present inventory, species followed by a (‡) were observed only in 2001.

TIMPANOGOS CAVE NATIONAL MONUMENT	
AMPHIBIANS	
None observed in 2001 or 2002	
LIZARDS	
*Sagebrush Lizard	*Sceloporus graciosus*
SNAKES	
*Gopher Snake‡	*Pituophis catenifer*
*Great Basin Rattlesnake	*Crotalus viridis lutosus*
*Rubber Boa‡	*Charina bottae*

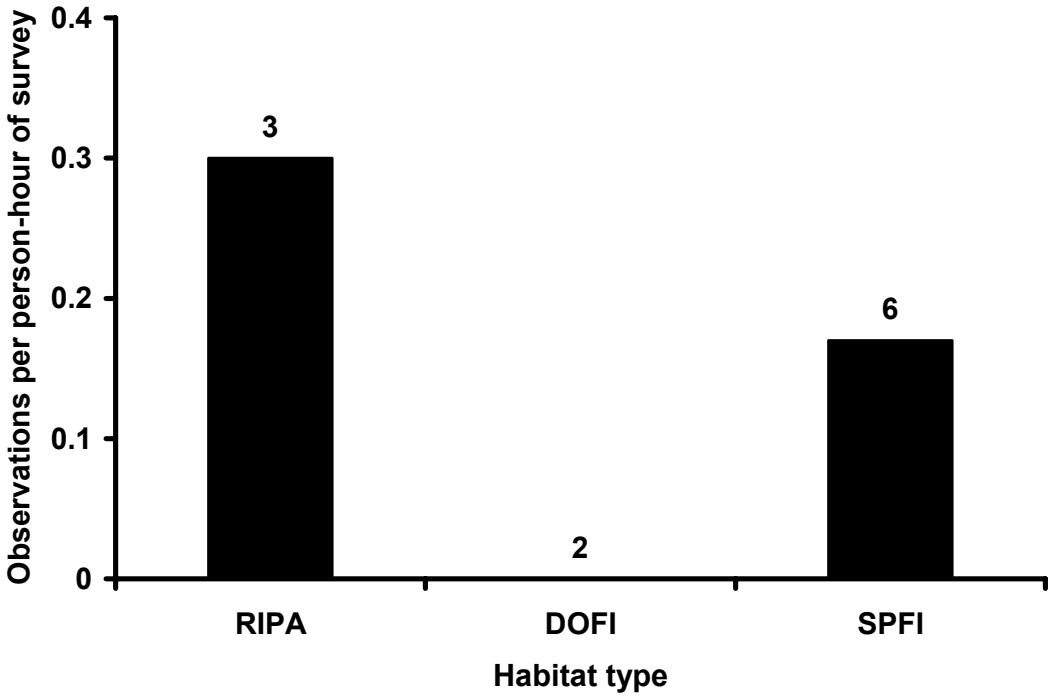

Figure 13. Survey effectiveness among habitat types sampled in TICA during 2002. **RIPA** = Riparian and canyon woodlands; **DOFI** = Douglas fir forest; **SPFI** = Spruce-fir forest. Numbers appearing over bars denote number of person-hours of survey expended in each habitat type.

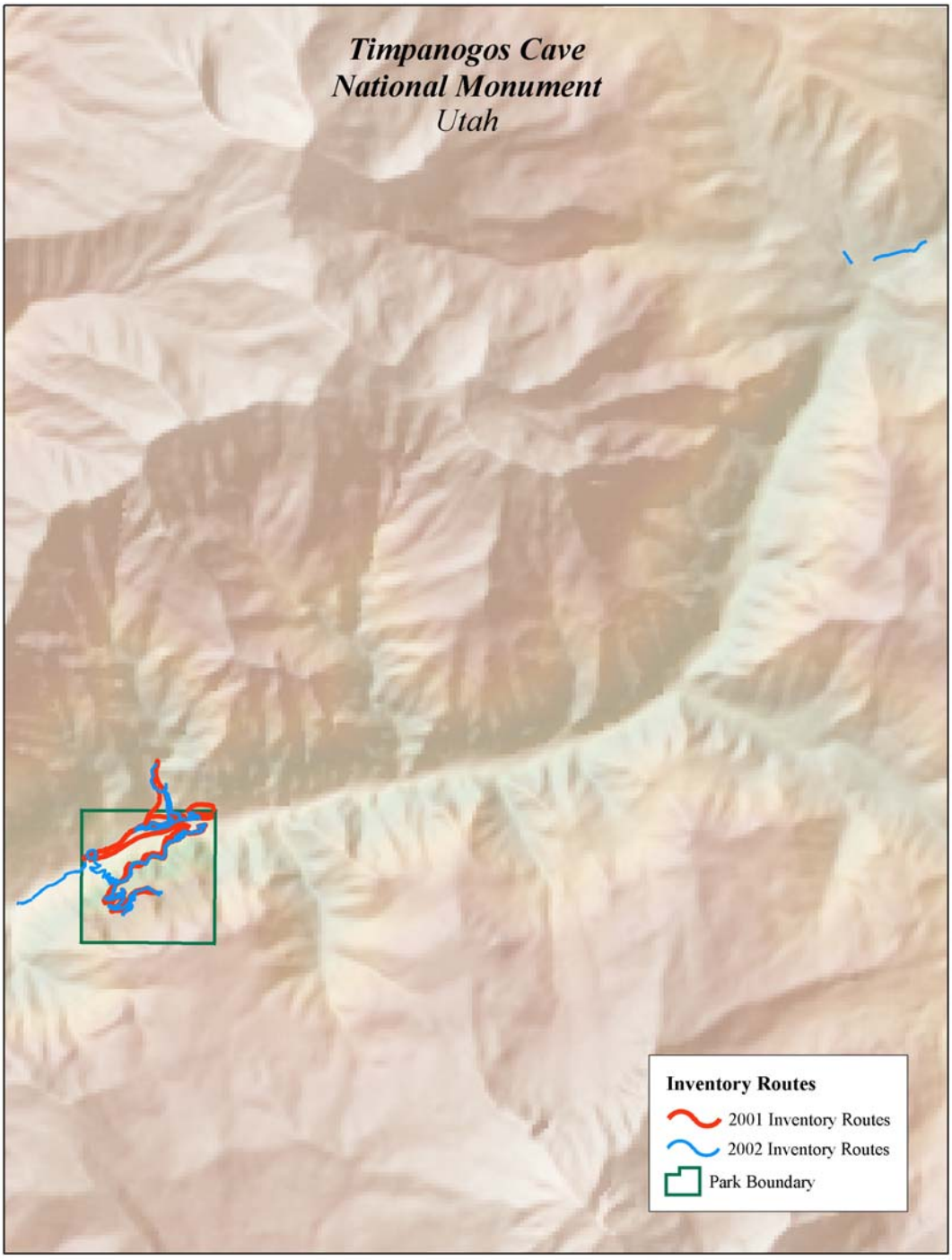

Figure 14a. Herpetofauna inventory effort in Timpanogos Cave National Monument and surrounding localities in 2001 and 2002.

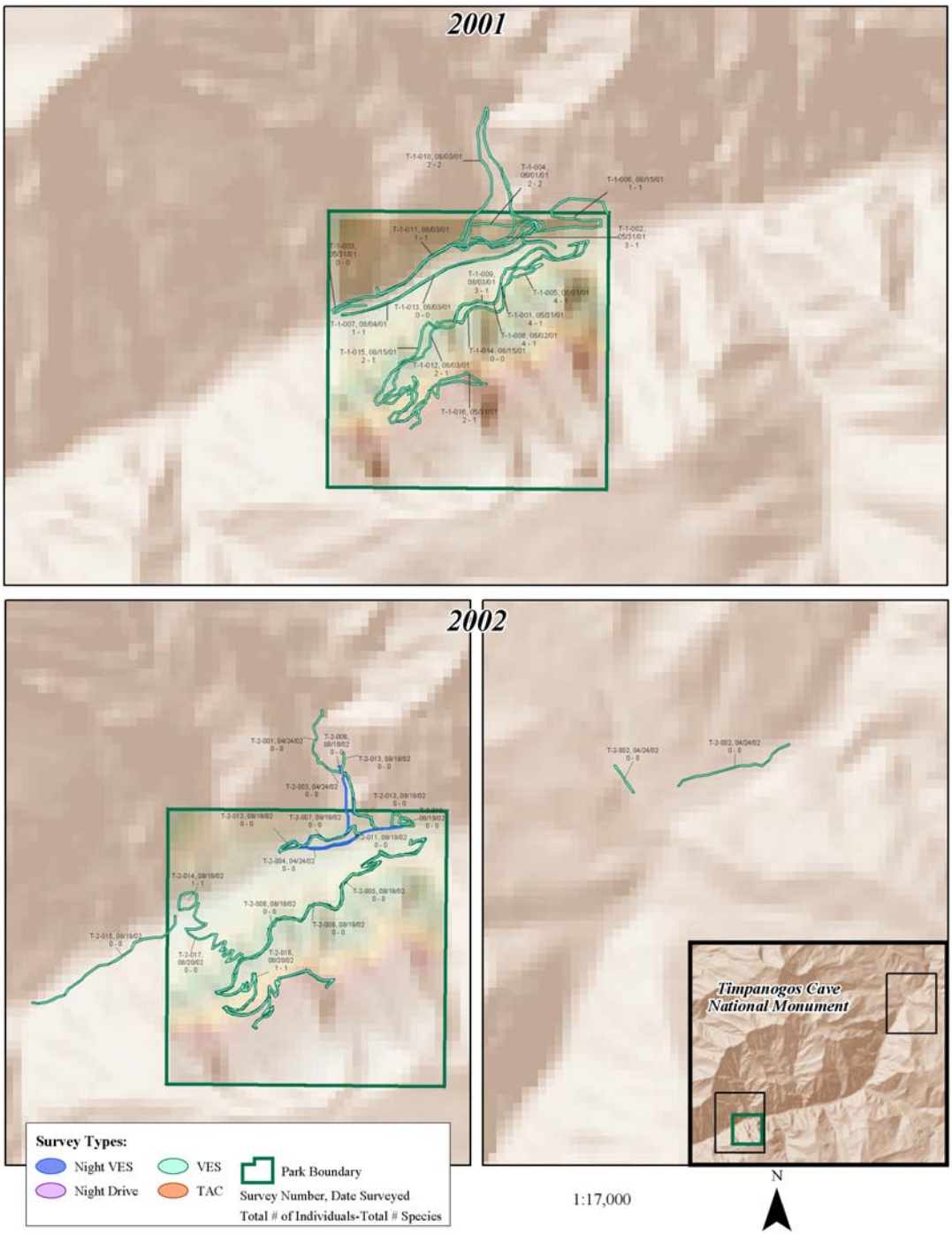

Figure 14b. Herpetofauna inventory effort in Timpanogos Cave National Monument. Line color depicts survey type, width of line shows survey coverage. Lines are labeled with survey number, date, and number of individual observations to number of species observed.

Zion National Park

During 2001 we conducted 93 surveys over four visits to ZION, of which 26 were one-hectare TACS, six were nighttime surveys, and six were night drives. We documented five amphibian, 11 lizard and four snake species from a total of 941 observations, and an additional three snake species from road killed specimens collected by park personnel (table 8). Documentation for two further snakes (the ringneck snake *Diadophis punctatus* and the Sonoran mountain kingsnake *Lampropeltis pyromelana*) was provided in photographic form by park rangers. We also found fresh scat and the shell of a dead desert tortoise (*Gopherus agassizii*).

Survey priorities for 2002 were to locate previously undocumented Mojave desert species in the southwest corner of the park, and higher-elevation snake species. We made three field visits, and conducted 46 surveys, of which five were nighttime surveys. Most of the 2002 survey effort was concentrated in the Coal Pits Wash area. We observed 602 individual specimens. Two previously undocumented species were observed, the coachwhip (*Masticophis flagellum*), and the chuckwalla (*Sauromalus obesus*), both of which were found in the southwestern section.

Six specimens were collection from Zion in 2001, consisting of one western whiptail (*Cnemidophorus tigris*), one side-blotched lizard (*Uta stansburiana*), one common kingsnake (*Lampropeltis getula*) one ground snake (*Sonora semiannulata*), and two gopher snakes (*Pituophis catenifer*). A further dried up piece of snake found on the maintenance road was identified by T. Persons as a western patch-nose snake (*Salvadora hexalepis*), but it was in too poor of condition to preserve. No voucher specimens were collected in 2002.

Figure 15 shows the level of effort expended in person-hours (time multiplied by the number of surveyors) in survey according to habitat type in 2002. Most of survey effort was spent in riparian and pinyon-juniper habitats, while ponderosa pine forests proved to be the most productive for herpetofauna sightings, primarily of the very abundant sagebrush lizard (*Sceloporus graciosus*). Figure 16 (a-g) shows survey locations by survey type in ZION for both 2001 and 2002.

Our estimated inventory completeness for ZION is 82%. There are six species that we were unable to document during this inventory. These are: the northern leopard frog (*Rana pipiens*), the night snake (*Hypsiglena torquata*), the lyre snake (*Trimorphodon biscutatus*), the banded gecko (*Coleonyx variegatus*), the gila monster (*Heloderma suspectum*), and the desert horned lizard (*Phrynosoma platyrhinos*). All of these species are extremely secretive and very difficult to observe, however, there are reliable accounts of these species occurring in ZION (B. Bartholomew and M. Sears, pers. comm.).

Table 8. Amphibian and reptile species observed at ZION in 2001 and 2002. An asterisk (*) denotes that a photo voucher has been collected for this species. Species in boldface had not been previously documented by the present inventory, species followed by a (‡) were observed only in 2001.

ZION NATIONAL PARK

AMPHIBIANS	
*Tiger Salamander‡	*Ambystoma tigrinum*
*Arizona Toad	*Bufo microscaphus*
*Canyon Treefrog	*Hyla arenicolor*
*Red-spotted Toad	*Bufo punctatus*
*Great Basin Spadefoot	*Spea intermontana*
TORTOISES	
Desert Tortoise‡	*Gopherus agassizii*
LIZARDS	
*Great Basin Collared Lizard	*Crotaphytus bicinctores*
*Longnose Leopard Lizard	*Gambelia wislizenii*
***Chuckwalla**	***Sauromalus obesus***
*Mountain Short Horned Lizard	*Phrynosoma hernandesi*
*Sagebrush Lizard	*Sceloporus graciosus*
*Desert Spiny Lizard	*Sceloporus magister*
*Eastern Fence Lizard	*Sceloporus undulatus*
*Tree Lizard	*Urosaurus ornatus*
*Side-blotched Lizard	*Uta stansburiana*
*Western Skink	*Eumeces skiltonianus*
*Western Whiptail	*Cnemidophorus tigris*
*Plateau Striped Whiptail	*Cnemidophorus velox*
SNAKES	
***Coachwhip**	***Masticophis flagellum***
*Striped Whipsnake	*Masticophis taeniatus*
*Gopher Snake	*Pituophis catenifer*
Mojave Patch-nosed Snake‡	*Salvadora hexalepis*
Ground Snake‡	*Sonora semiannulata*
Common Kingsnake‡	*Lampropeltis getula*
Sonoran Mountain Kingsnake‡ digital image documentation provided by park staff	*Lampropeltis pyromelana*
Ringneck Snake‡ digital image documentation provided by park staff	*Diadophis punctatus*
Wandering Garter Snake‡	*Thamnophis elegans vagrans*
*Great Basin Rattlesnake	*Crotalus viridis lutosus*

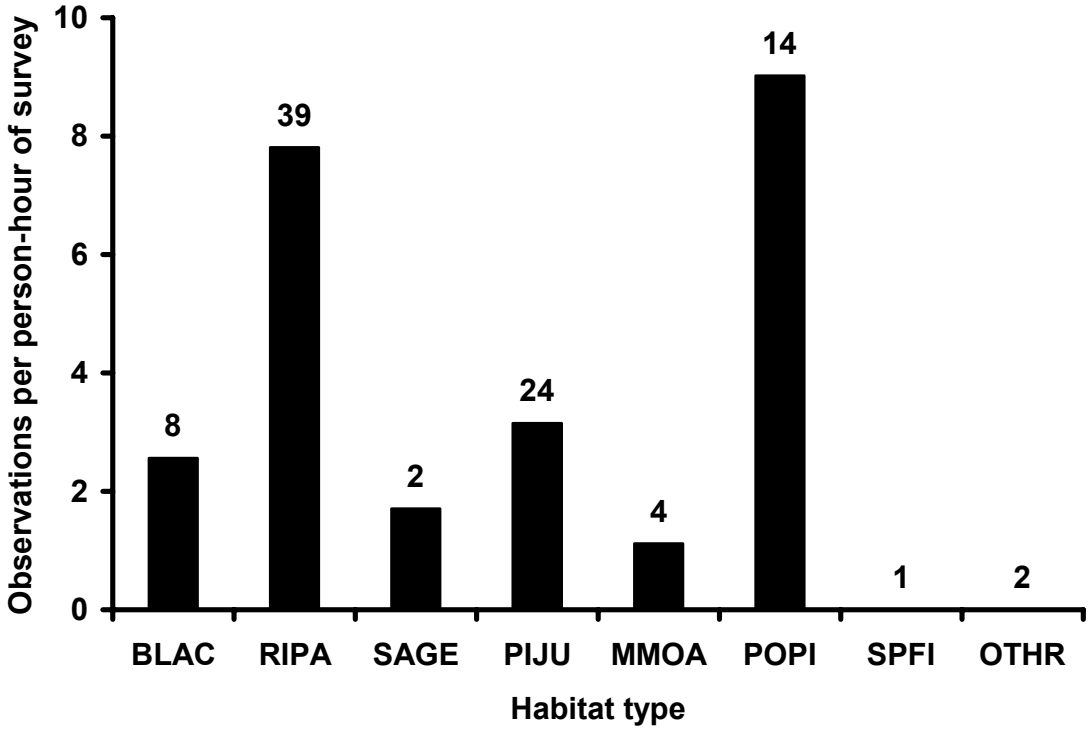

Figure 15. Survey effectiveness among habitat types sampled in ZION during 2002. **BLAC** = Blackbrush shrublands; **RIPA** = Riparian and canyon woodlands; **SAGE** = Great Basin sagebrush; **PIJU** = Pinyon-juniper woodlands; **MMOA** = Mountain mahogany-oak shrublands; **POPI** = Ponderosa pine woodlands and forest; **SPFI** = Spruce-fir forest; **OTHR** = Other habitat types. Numbers appearing over bars denote number of person-hours of survey expended in each habitat type.

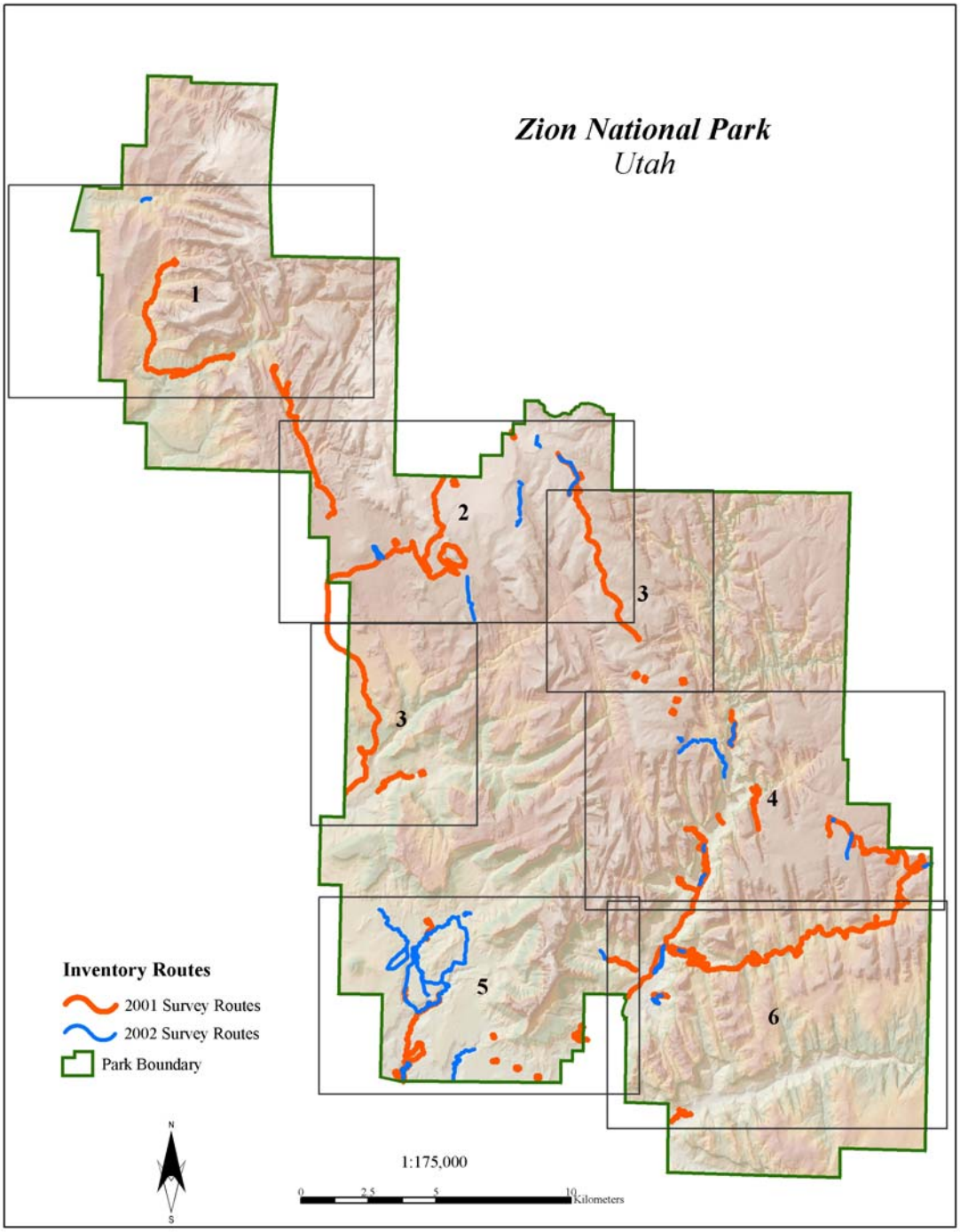

Figure 16a. Herpetofauna inventory effort in Zion National Park in 2001 and 2002. Numbered insets refer to subsequent maps detailing survey information.

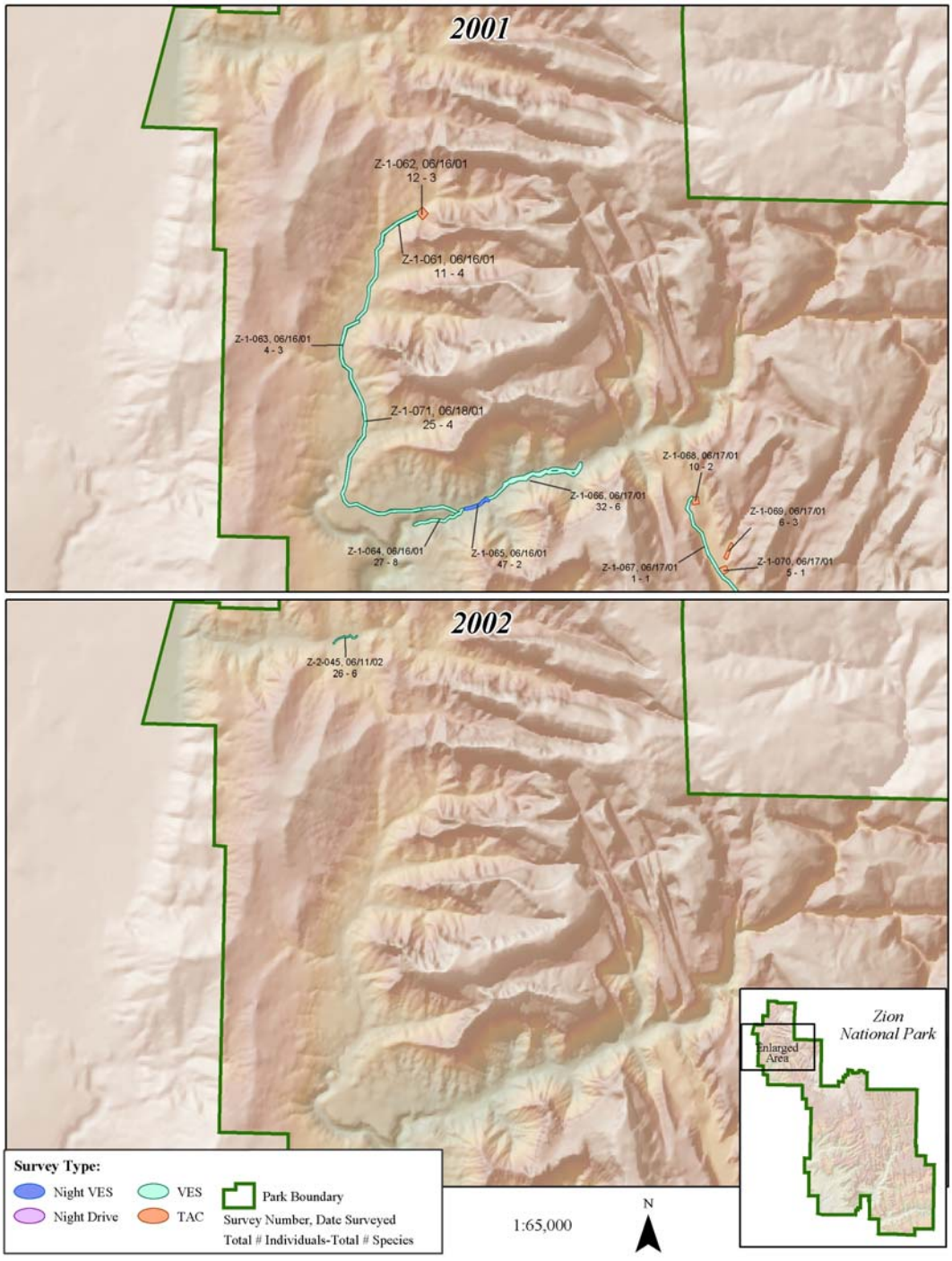

Figure 16b. Herpetofauna inventory effort in Zion National Park, subsection 1. Line color depicts survey type, width of line shows survey coverage. Lines are labeled with survey number, date, and number of individual observations to number of species observed.

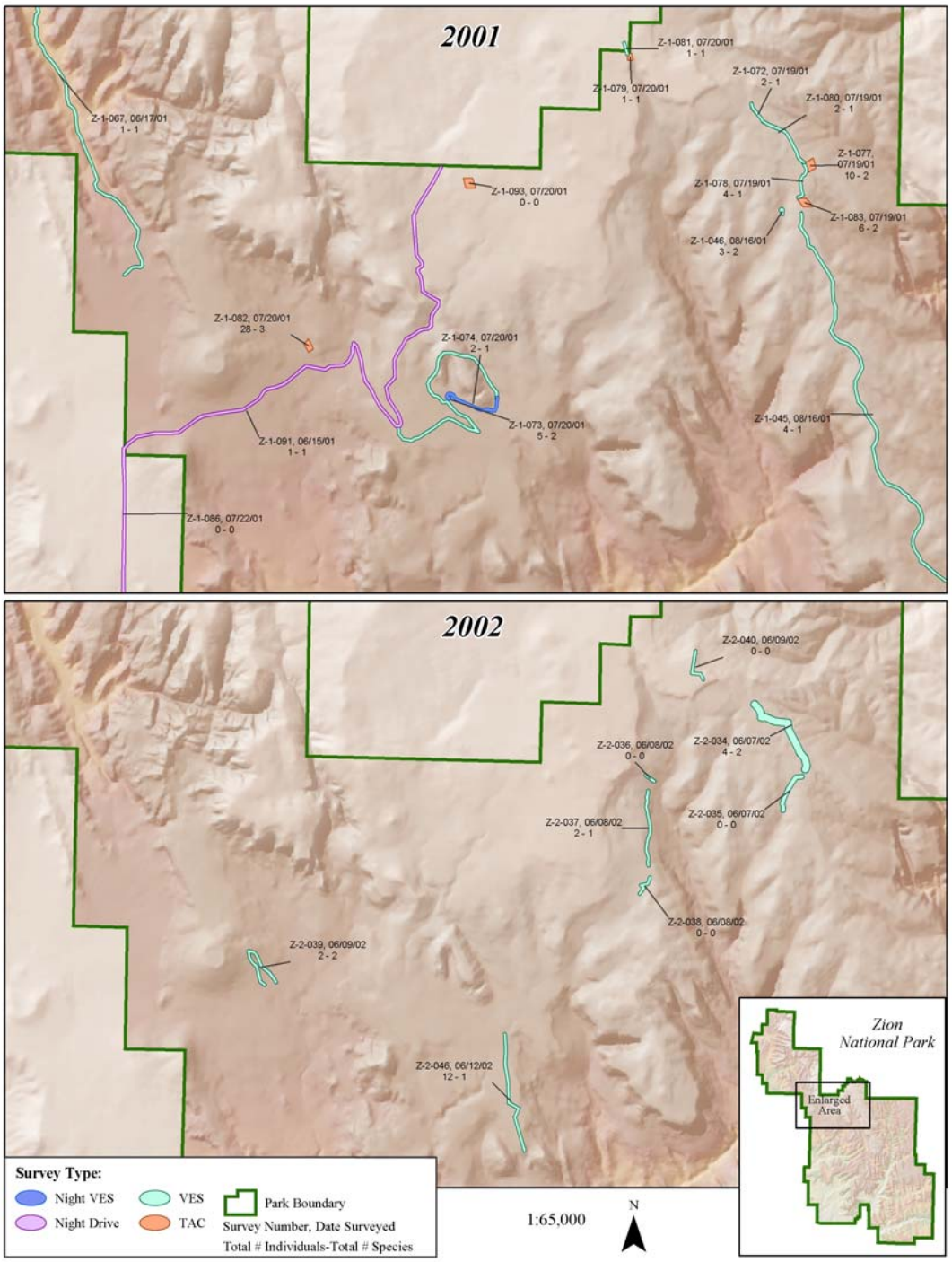

Figure 16c. Herpetofauna inventory effort in Zion National Park, subsection 2. Line color depicts survey type, width of line shows survey coverage. Lines are labeled with survey number, date, and number of individual observations to number of species observed.

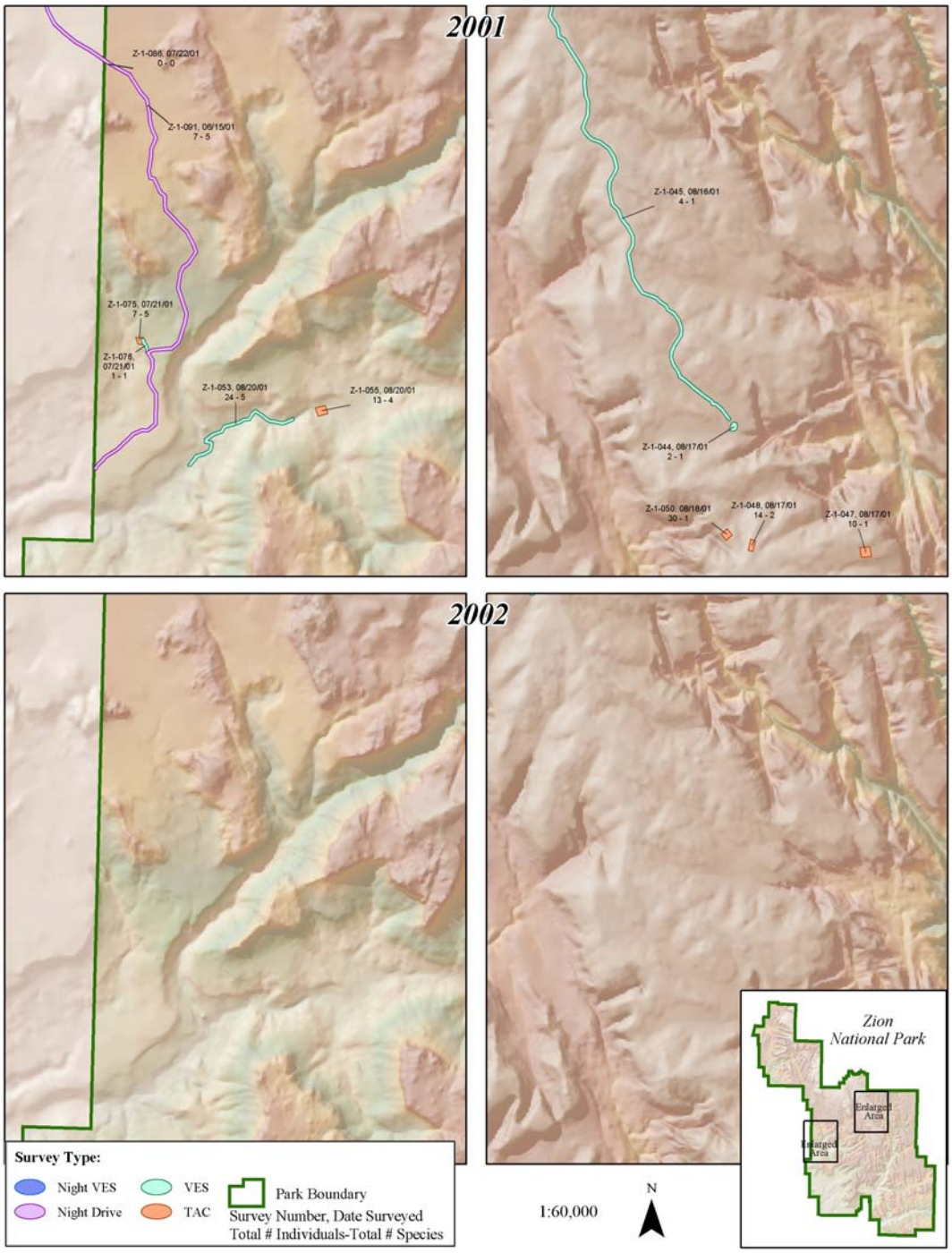

Figure 16d. Herpetofauna inventory effort in Zion National Park, subsections 3. Line color depicts survey type, width of line shows survey coverage. Lines are labeled with survey number, date, and number of individual observations to number of species observed.

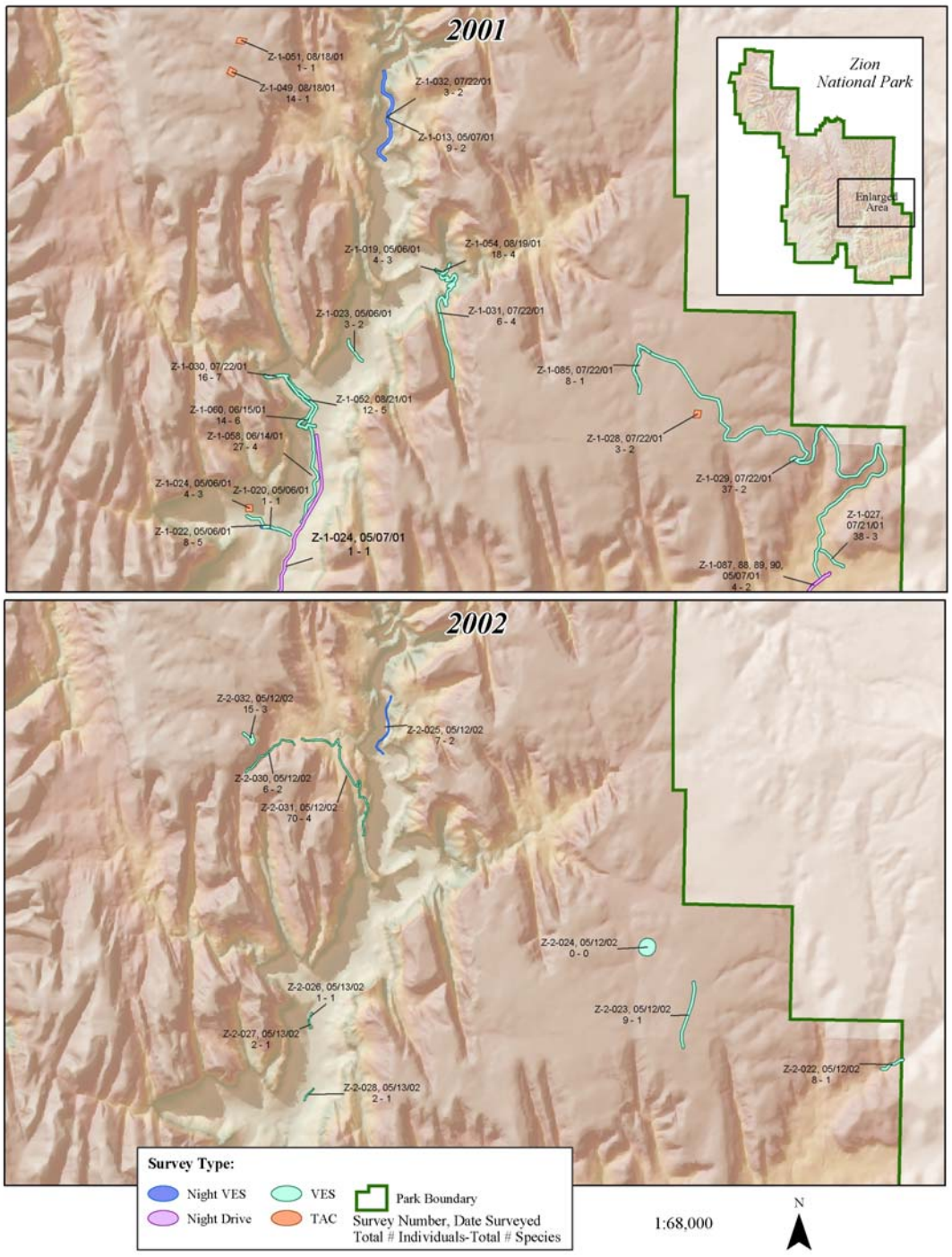

Figure 16e. Herpetofauna inventory effort in Zion National Park, subsection 4. Line color depicts survey type, width of line shows survey coverage. Lines are labeled with survey number, date, and number of individual observations to number of species observed.

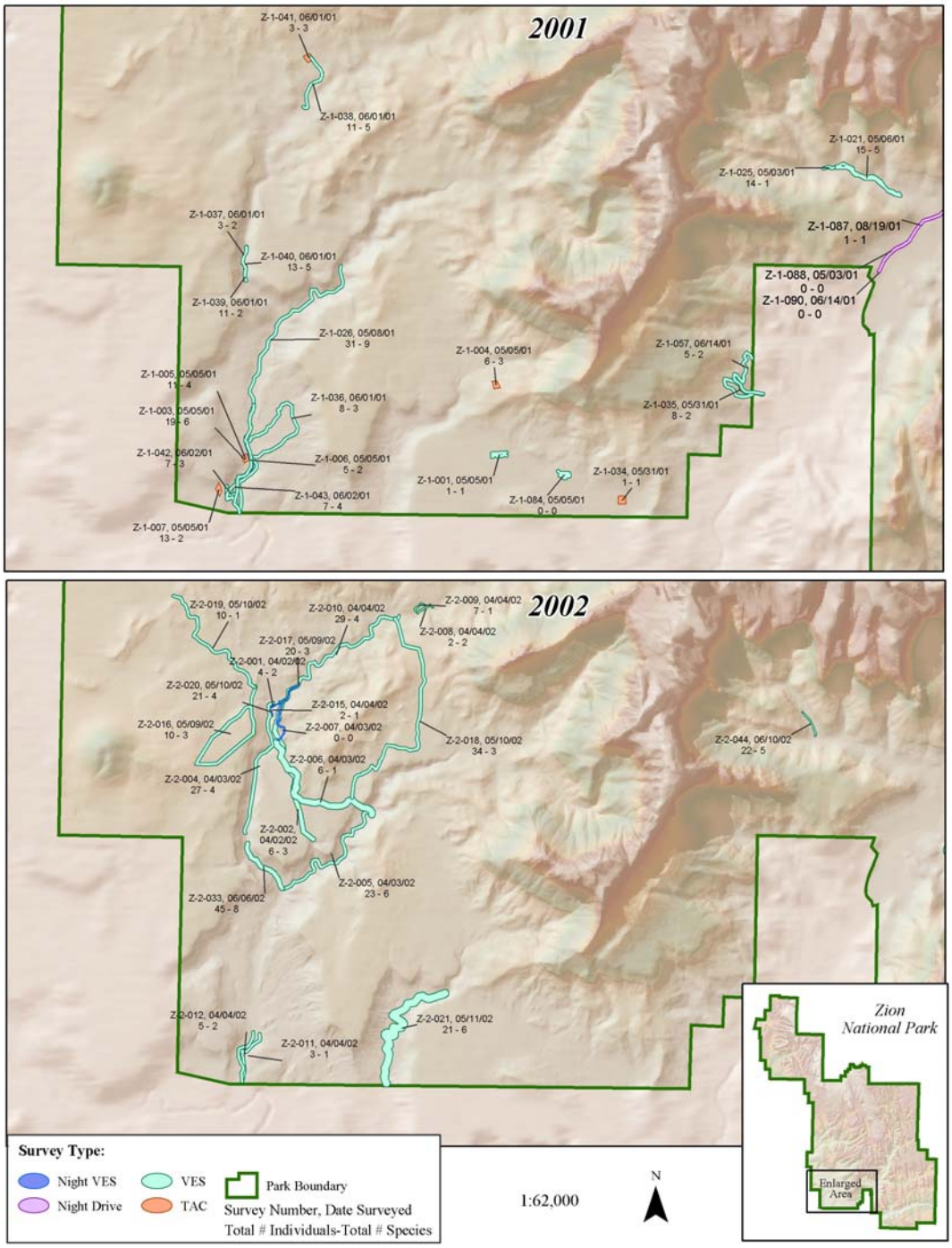

Figure 16f. Herpetofauna inventory effort in Zion National Park, subsection 5. Line color depicts survey type, width of line shows survey coverage. Lines are labeled with survey number, date, and number of individual observations to number of species observed.

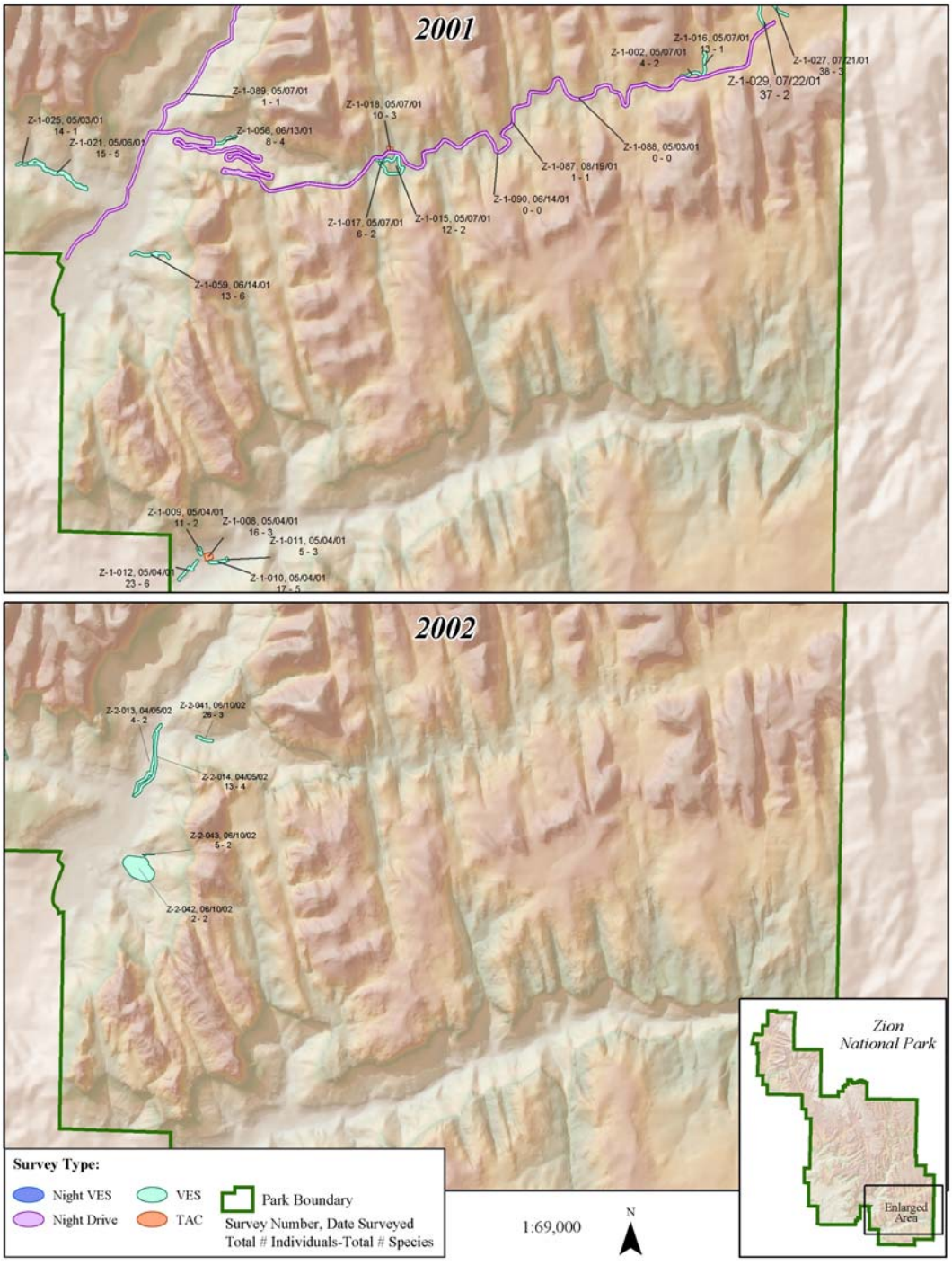

Figure 16g. Herpetofauna inventory effort in Zion National Park, subsection 6. Line color depicts survey type, width of line shows survey coverage. Lines are labeled with survey number, date, and number of individual observations to number of species observed.

Individual Park Findings: First-year Parks

The accounts that follow summarize the field effort and findings in each of the park units that received two years of survey. They include maps of the park units, showing the entire park unit and survey routes for both years, and enlargements of subsections of the park. Each enlargement shows routes color-coded by survey type (VES, night VES, TAC, and night drive, and labeled according to survey number, date, and number of observations to number of species observed.

Appendix 3 lists the field survey schedules for 2001 and 2002. Appendix 4 summarizes the experience and qualifications of the field survey personnel.

Arches National Park

The survey priority for the first year of inventory at ARCH was to document the common diurnal species. We conducted 32 surveys between 27 March and 22 September, including four night drives, with visits to the park made on an *ad hoc* basis throughout the season. We made 393 individual observations, and documented 12 species (three amphibians, seven lizards, two snakes, table 9) inside the park and one additional lizard species just outside the park boundary (mountain short-horned lizard *Phrynosoma hernandesi*). Documentation for a further amphibian species (*Spea intermontana*) was provided by the ARMI (Amphibian Research and Monitoring Initiative) field crew. Two specimens, one each of the eastern fence lizard (*Sceloporus undulatus*) and the red-spotted toad (*Bufo punctatus*) were salvaged as road-kills for voucher specimens.

Figure 17 shows the level of effort expended in person-hours (time multiplied by the number of surveyors) in survey according to habitat type in 2002. Most of survey effort was conducted in riparian and blackbrush habitats, while riparian, wetland, and salt desert scrub were the most productive habitats for herpetofauna sightings. Figure 18 (a-c) shows survey locations by survey type conducted during 2002.

We attained an estimated inventory completeness of 61% after one season of survey. There were nine expected species that we were unable to document during 2002: tiger salamander (*Ambystoma tigrinum*), northern leopard frog (*Rana pipiens*), Great Plains rat snake (*Elaphe guttata emoryi*), night snake (*Hypsiglena torquata*), gopher snake (*Pituophis catenifer*), southwestern blackhead snake (*Tantilla hobartsmithi*), western terrestrial garter snake (*Thamnophis elegans*), midget faded rattlesnake (*Crotalus viridis* concolor), and plateau striped whiptail (*Cnemidophorus velox*). All of these species are known from around the Moab area, and it is expected that they would occur within ARCH as well. Three additional species should be put on a watch list for the park: canyon treefrog (*Hyla arenicolor*), racer (*Coluber constrictor*) and night lizard (*Xantusia vigilis*). The treefrog is known from similar habitat types around the Moab vicinity, and both the treefrog and racer are reported to occur in ARCH (Hammerson, 1999) but have not been reported directly from ARCH itself. The night lizard is an extremely secretive species, with only one published account of a sighting east of the Colorado River (Tanner, 1958). It is unknown whether it occurs in ARCH.

Table 9. Amphibian and reptile species observed at ARCH in 2002. An asterisk (*) denotes that a photo voucher was collected for this species.

ARCHES NATIONAL PARK	
AMPHIBIANS	
Red-spotted Toad	*Bufo punctatus*
*Woodhouse's Toad	*Bufo woodhousii*
Bullfrog	*Rana catesbeiana*
Great Basin Spadefoot (documented by ARMI)	*Spea intermontana*
LIZARDS	
Western Whiptail	*Cnemidophorus tigris*
Collared Lizard	*Crotaphytus collaris*
*Longnose Leopard Lizard	*Gambelia wislizenii*
Sagebrush Lizard	*Sceloporus graciosus*
*Mountain Short-horned Lizard	*Phrynosoma hernandesi*
*Eastern Fence Lizard	*Sceloporus undulatus*
*Tree Lizard	*Urosaurus ornatus*
Side-blotched Lizard	*Uta stansburiana*
SNAKES	
*Striped Whipsnake	*Masticophis taeniatus*
*Blackneck Garter Snake	*Thamnophis cyrtopsis*

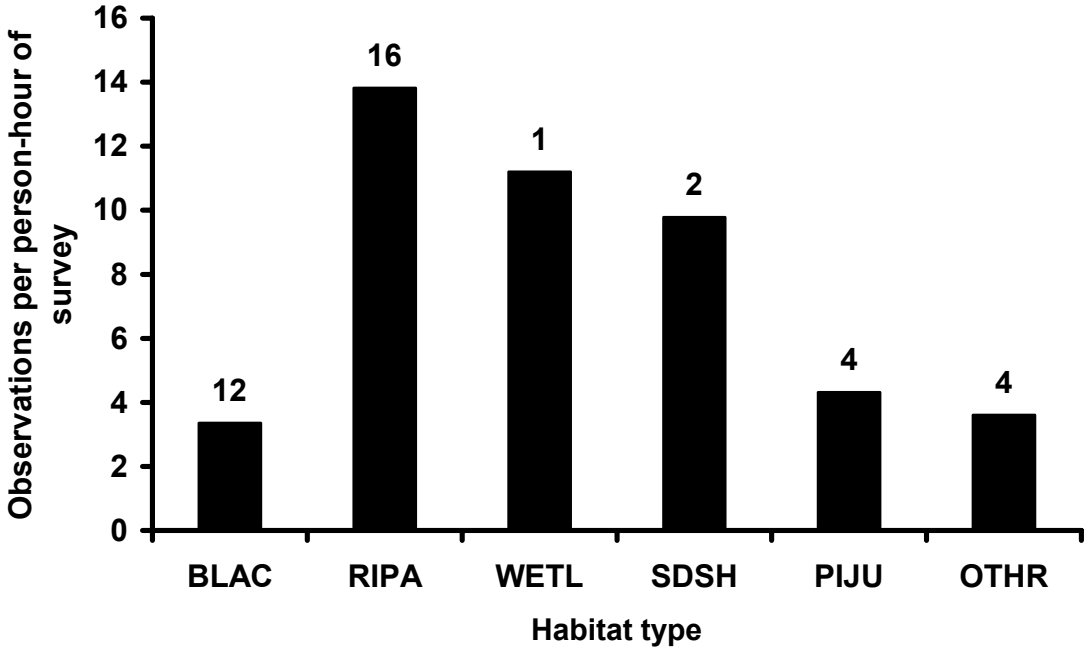

Figure 17. Survey effectiveness among habitat types sampled in ARCH during 2002. **BLAC** = Blackbrush shrublands; **RIPA** = Riparian and canyon woodlands; **WETL** = Wetland; **SDSH** = Salt desert scrub; **PIJU** = Pinyon-juniper woodlands; **OTHR** = Other habitat types.

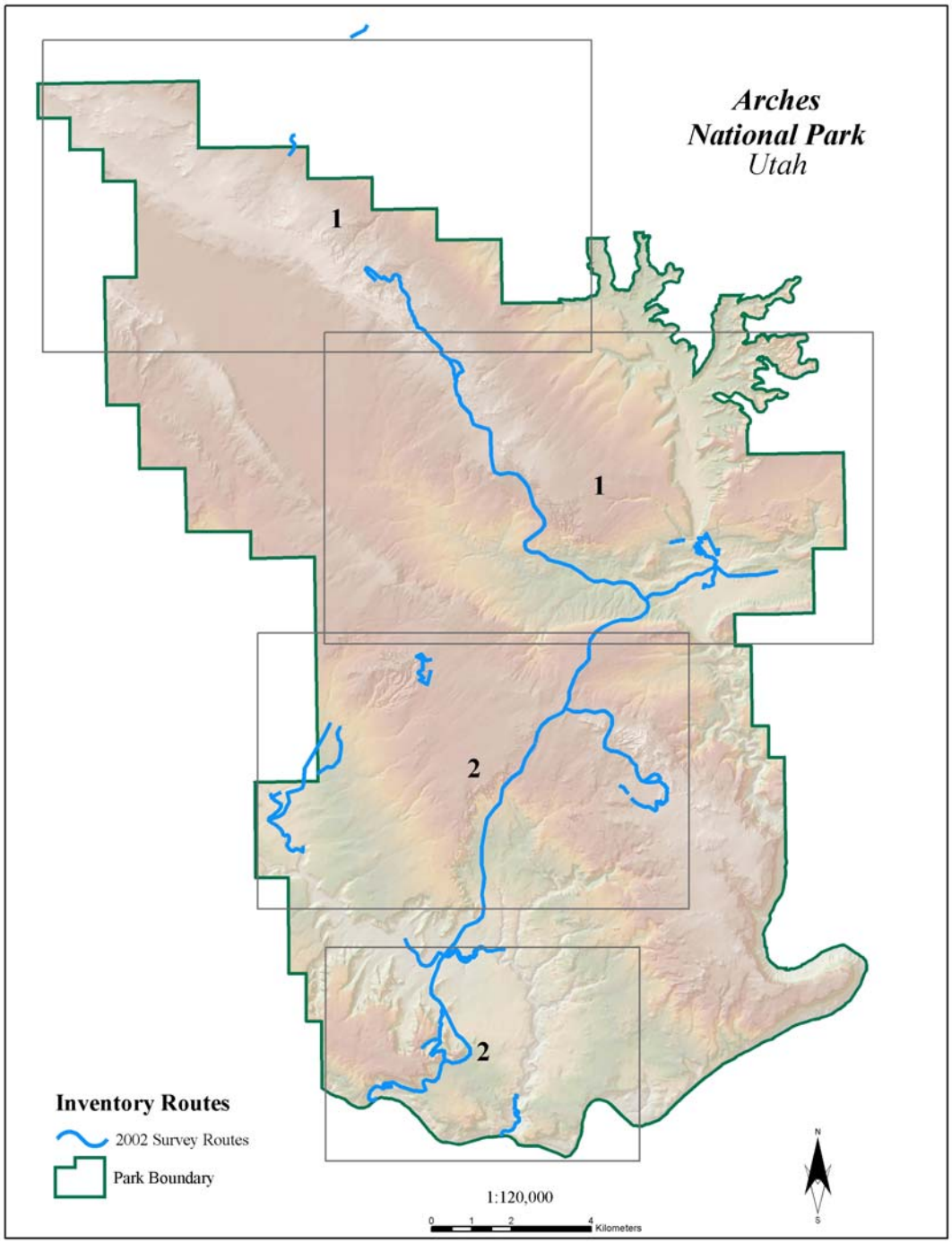

Figure 18a. Herpetofauna inventory effort in Arches National Park in 2002. Numbered insets refer to subsequent maps detailing survey information.

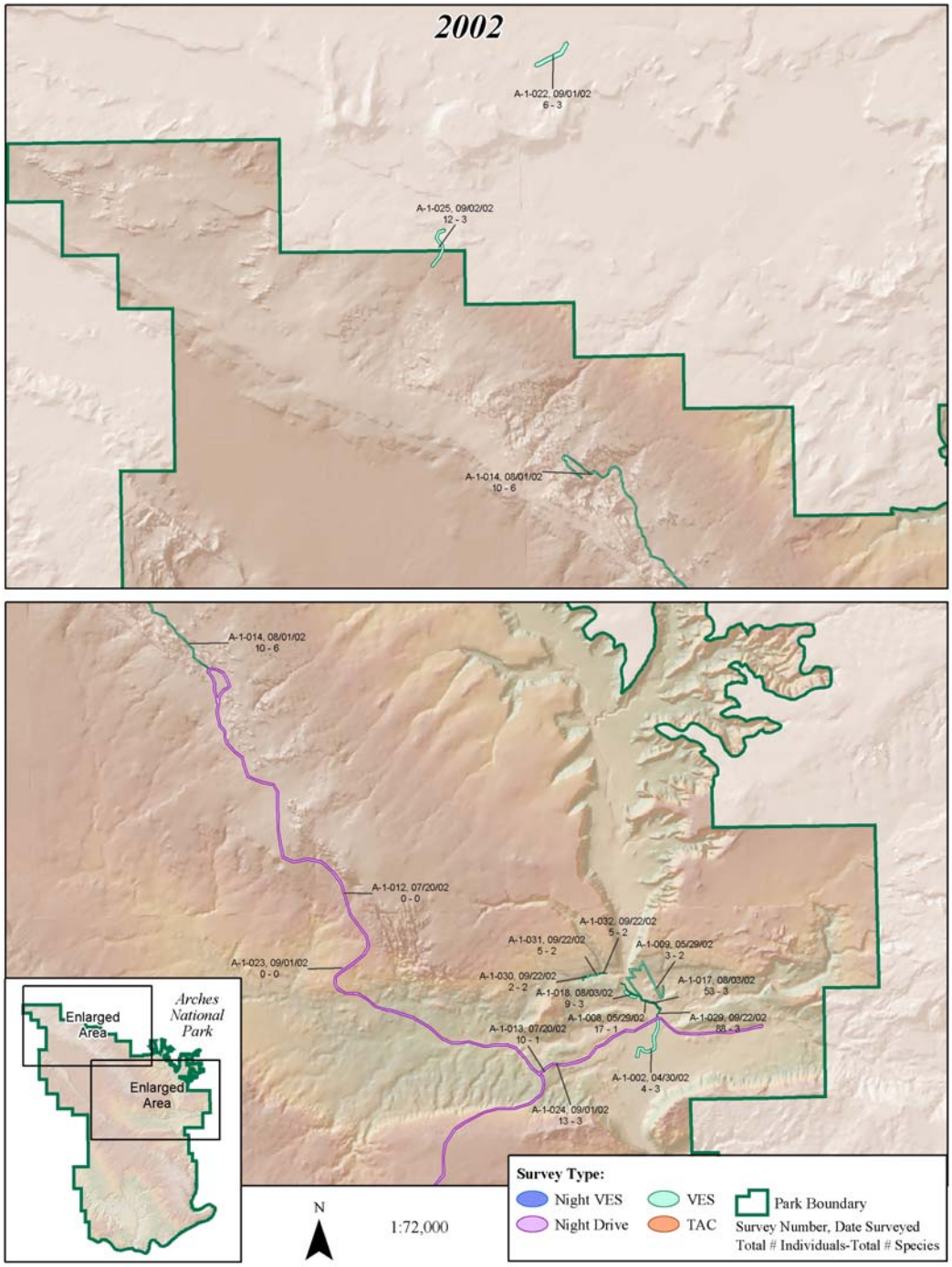

Figure 18b. Herpetofauna inventory effort in Arches National Park, subsections 1. Line color depicts survey type, width of line shows survey coverage. Lines are labeled with survey number, date, and number of individual observations to number of species observed.

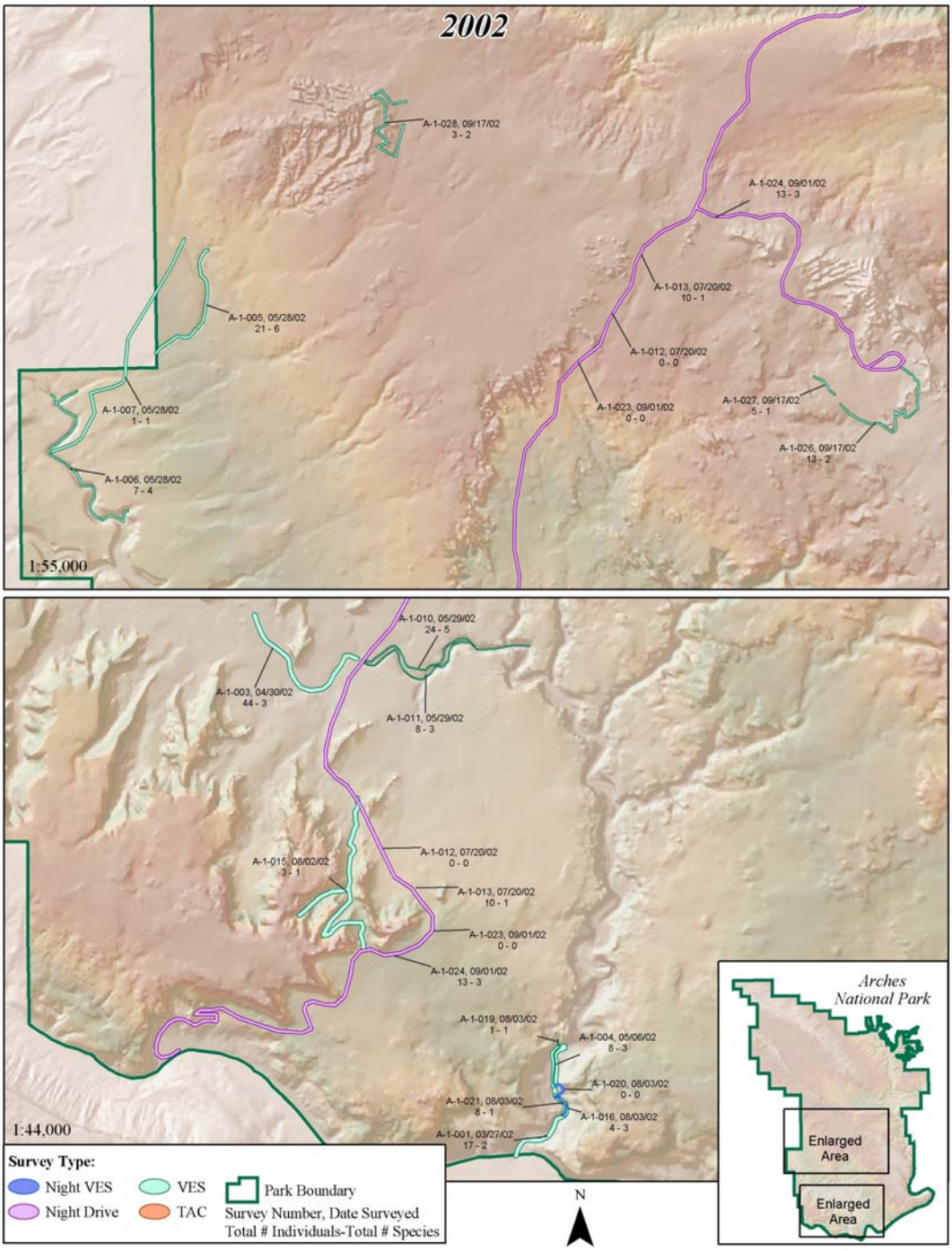

Figure 18c. Herpetofauna inventory effort in Arches National Park, subsections 2. Line color depicts survey type, width of line shows survey coverage. Lines are labeled with survey number, date, and number of individual observations to number of species observed.

Colorado National Monument

The survey priority for the first year of inventory at COLM was to document the common reptile and amphibian species. We conducted 26 surveys, including six night drive surveys, during two field visits. We made 280 individual observations, documenting 11 species, including two amphibians, seven lizards, and two snake species (table 10). We observed an additional snake species just outside the park boundary. Two of these snakes, the night snake (*Hypsiglena torquata*) and the western rattlesnake (*Crotalus viridis*) are rare sightings for the park, and were both observed during nighttime road driving surveys after a rare rainfall event. The rattlesnake was observed just outside of the park boundary on the southeastern access road (Monument Drive), and has been included in the species list due to its proximity to the monument boundary (the taxonomy of the western rattlesnakes in Colorado is under debate (Hammerson, 1999), therefore no subspecies has been assigned to this observation). No specimens were collected from this park unit during 2002.

Figure 19 shows the level of effort expended in person-hours (time multiplied by the number of surveyors) in survey according to habitat type in 2002. Most of survey effort was conducted in pinyon-juniper woodlands, the dominant habitat type at COLM, while riparian habitats proved to be the most productive for herpetofauna sightings. Figure 20 (a-b) shows survey locations by survey type conducted in COLM in 2002.

Our estimated inventory completeness for COLM after one season of survey is 52%. We estimate that there are a further 11 species that we were unable to document in 2002: tiger salamander (*Ambystoma tigrinum*), red-spotted toad (*Bufo punctatus*), canyon treefrog (*Hyla arenicolor*), northern leopard frog (*Rana pipiens*), Great Plains rat snake (*Elaphe guttata emoryi*), gopher snake (*Pituophis catenifer*), southwestern blackhead snake (*Tantilla hobartsmithi*), western terrestrial garter snake (*Thamnophis elegans*), milk snake (*Lampropeltis triangulum*), longnose leopard lizard (*Gambelia wislizenii*), mountain short-horned lizard (*Phrynosoma hernandesi*). There is reliable evidence that these species all occur within COLM (Hammerson, 1999).

Table 10. Amphibian and reptile species observed at COLM in 2002. An asterisk (*) denotes that a photo voucher was collected for this species.

COLORADO NATIONAL MONUMENT	
AMPHIBIANS	
*Woodhouse's Toad	*Bufo woodhousii*
Great Basin Spadefoot	*Spea intermontana*
LIZARDS	
*Collared lizard	*Crotaphytus collaris*
Sagebrush Lizard	*Sceloporus graciosus*
*Eastern Fence Lizard	*Sceloporus undulatus*
*Tree Lizard	*Urosaurus ornatus*
Side-blotched Lizard	*Uta stansburiana*
Western Whiptail	*Cnemidophorus tigris*
*Plateau Striped Whiptail	*Cnemidophorus velox*
SNAKES	
*Striped Whipsnake	*Masticophis taeniatus*
*Night Snake	*Hypsiglena torquata*
*Western Rattlesnake	*Crotalus viridis*

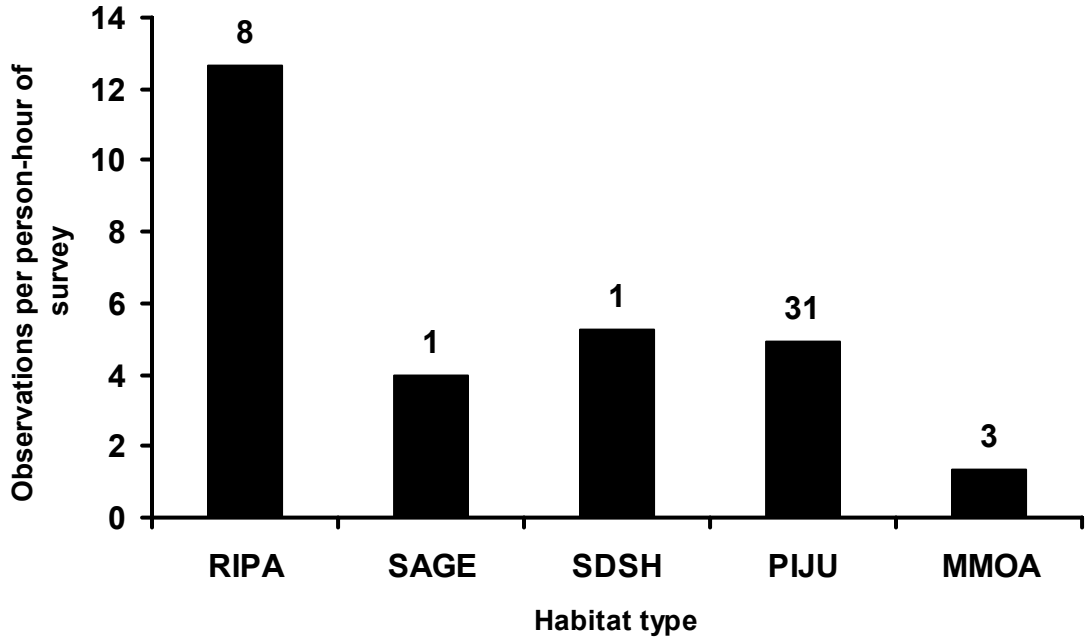

Figure 19. Survey effectiveness among habitat types sampled in COLM during 2002. **RIPA** = Riparian and canyon woodlands; **SAGE** = Great Basin sagebrush; **SDSH** = Salt desert scrub; **PIJU** = Pinyon-juniper woodlands; **MMOA** = Mountain mahogany-oak shrublands. Numbers appearing over bars denote number of person-hours of survey expended in each habitat type.

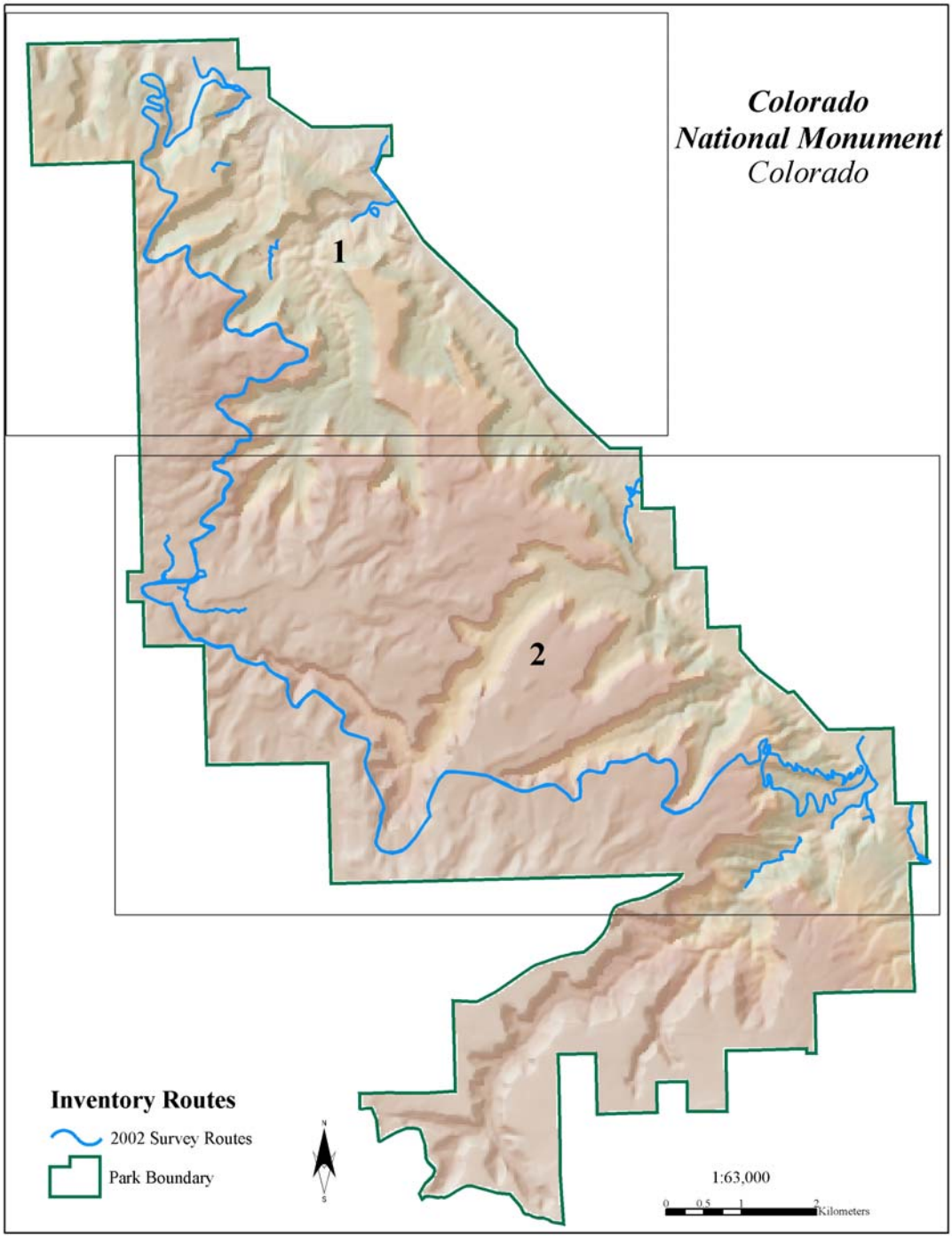

Figure 20a. Herpetofauna inventory effort in Colorado National Monument in 2002. Numbered insets refer to subsequent maps detailing survey information.

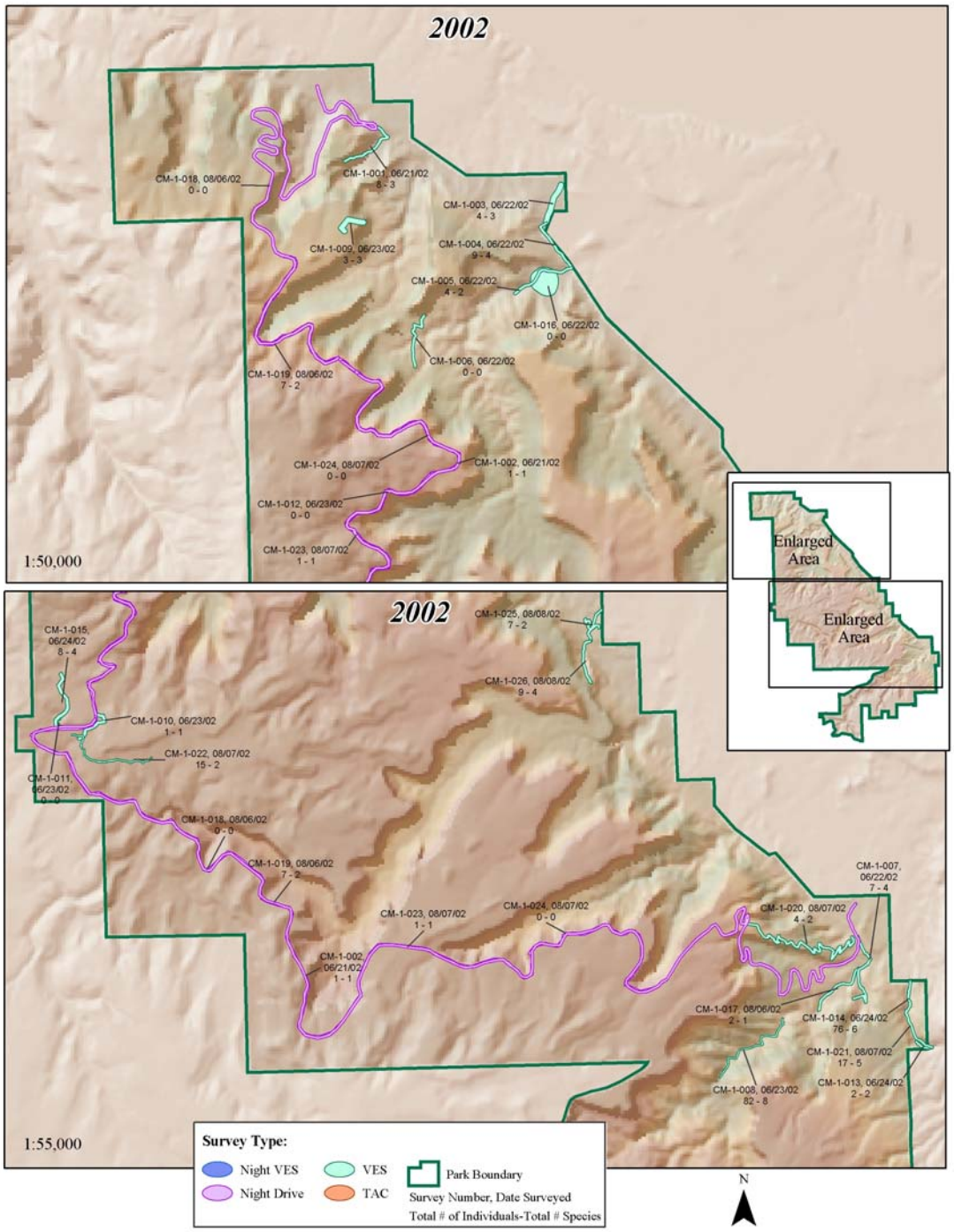

Figure 20b. Herpetofauna inventory effort in Colorado National Monument, subsections 1 and 2. Line color depicts survey type, width of line shows survey coverage. Lines are labeled with survey number, date, and number of individual observations to number of species observed.

Natural Bridges National Monument

Survey priorities in 2002 were to locate and document the common diurnal species and less abundant snake species. Four field visits were made, and 30 surveys were conducted, including six night drive surveys. We made 302 individual observations. Six amphibian species were recorded, as well as five lizards and one snake (table 11).

Figure 21 shows the level of effort expended in person-hours (time multiplied by the number of surveyors) in survey according to habitat type in 2002. There are only three major habitat types in NABR: riparian, pinyon-juniper, and small pockets of Douglas fir forest. Most of survey effort in 2002 was conducted in pinyon-juniper habitat, with the majority of sightings being in the riparian zone. Figure 22 (a-b) shows survey locations by survey type.

Our estimated inventory completeness for NABR is 67%. We estimate that we have found all the amphibians species present, and that there are a further six reptile species that we did not document in 2002: night snake (*Hypsiglena torquata*), striped whipsnake (*Masticophis taeniatus*), gopher snake (*Pituophis catenifer*), western collared lizard (*Crotaphytus collaris*), mountain short-horned lizard (*Phrynosoma hernandesi*), and night lizard (*Xantusia vigilis*). A further five snake species should be added to a watch list: glossy snake (*Arizona elegans*), common kingsnake (*Lampropeltis getula*), longnose snake (*Rhinocheilus lecontei*), blackneck garter snake (*Thamnophis cyrtopsis*) and western terrestrial garter snake (*Thamnophis elegans*).

There is some confusion surrounding the status and taxonomy of the spadefoot toads (*Spea* spp.) in NABR, it is likely that two species occur there, *Spea intermontana* and *Spea multiplicata*, with the possibility of hybridization between them. We are awaiting positive identification of voucher specimens and photographs to determine taxonomic status of the *Spea* in this park unit. One *Spea* sp. adult and one metamorph were collected from Armstrong Canyon for analysis.

There is also confusion surrounding the taxonomy of the rattlesnake. In appearance the species present at NABR most closely resembles *Crotalus viridis viridis*, although its venom suggests an intergrade between *C.v. viridis* and *C.v. concolor* (Glenn, 1991). Further research needs to be conducted on this population.

Table 11. Amphibian and reptile species observed at NABR in 2002. An asterisk (*) denotes that a photo voucher was collected for this species.

NATURAL BRIDGES NATIONAL MONUMENT	
AMPHIBIANS	
*Tiger Salamander	*Ambystoma tigrinum*
*Red-spotted Toad	*Bufo punctatus*
Woodhouse's Toad	*Bufo woodhousii*
Canyon Tree Frog	*Hyla arenicolor*
*Spadefoot Toads (exact identification uncertain)	*Spea* spp.
*Northern Leopard Frog	*Rana pipiens*
LIZARDS	
*Sagebrush Lizard	*Sceloporus graciosus*
Eastern Fence Lizard	*Sceloporus undulatus*
*Tree Lizard	*Urosaurus ornatus*
Side-blotched Lizard	*Uta stansburiana*
Plateau Striped Whiptail	*Cnemidophorus velox*
SNAKES	
*Western Rattlesnake	*Crotalus viridis*

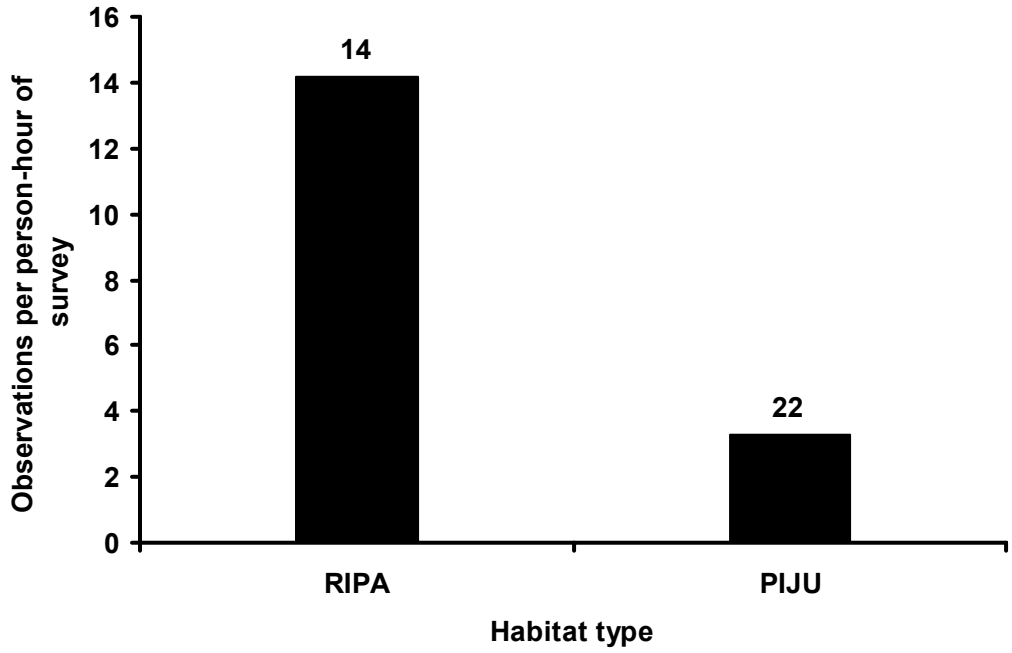

Figure 21. Survey effectiveness among habitat types sampled in NABR during 2002. **RIPA** = Riparian and canyon woodlands; **PIJU** = Pinyon-juniper woodlands. Numbers appearing over bars denote number of person-hours of survey expended in each habitat type.

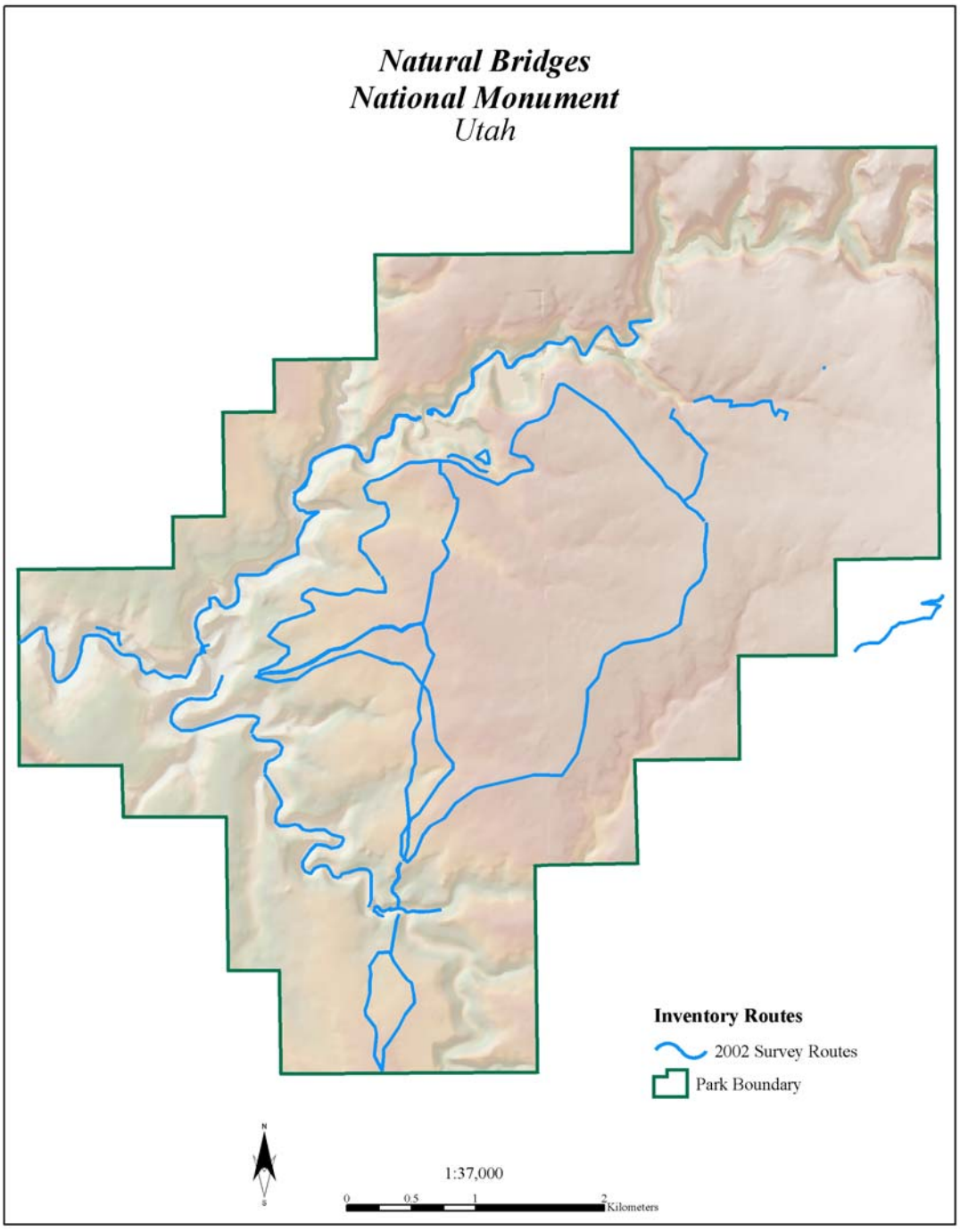

Figure 22a. Herpetofauna inventory effort in Natural Bridges National Monument in 2002.

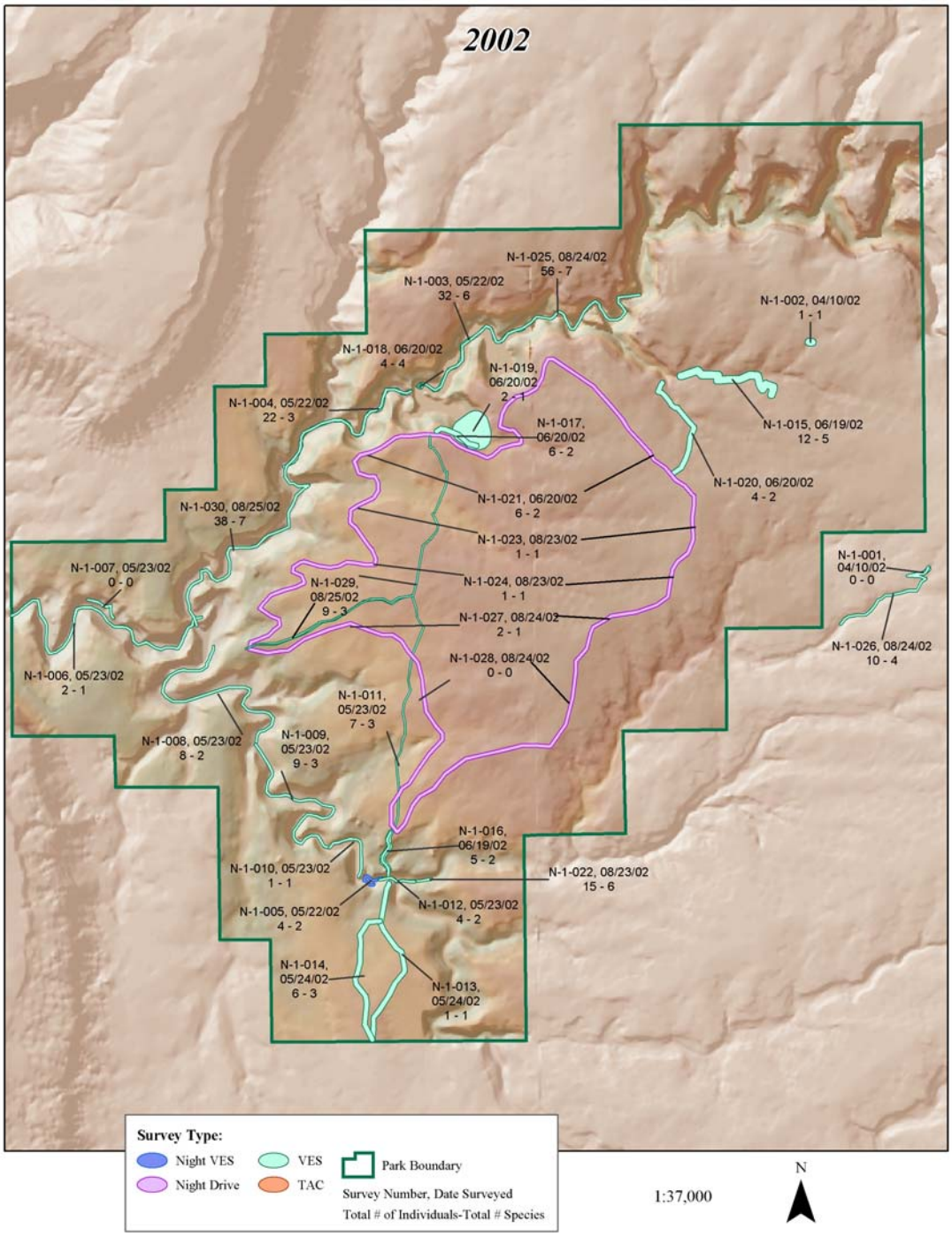

Figure 22b. Herpetofauna inventory effort in Natural Bridges National Monument. Line color depicts survey type, width of line shows survey coverage. Lines are labeled with survey number, date, and number of individual observations to number of species observed.

Field Effort Results and Discussion

Overview

In 2001 we made nine 7-day field trips to eight NCPN park units (BRCA, CARE, CEBR, FOBU, GOSP, PISP, TICA, ZION) between 3 May and 4 September, resulting in 33 park visits over a total of 103 field days. Appendix 3 lists the field visits and survey teams involved. We spent a total of 965 person-hours (number of people conducting any given survey multiplied by the number of hours per survey) on inventory effort (table 12). During this time we conducted 340 surveys. Based on data collected in 2002 (see methods), we estimate that approximately 20% of total survey time was spent on activities other than searching for specimens, such as map reading, specimen processing, georeferencing, etc.). The effort shown under the various survey methods in table 12 reflect total survey time less 20%.

In 2002 we made eleven field trips to ten NCPN park units (BRCA, CARE, CEBR, COLM, FOBU, GOSP, NABR, PISP, TICA, ZION) between 1 April and 11 September 2002, with additional visits to ARCH between 27 March and 22 September, for a total of 72 field days. Appendix 3 lists the field visits and survey teams involved. We spent a total of 453 person-hours on inventory: 143 person-hours (32%) in first-year parks (those parks receiving one year of survey) and 310 person-hours (68%) in second-year parks (those receiving two years of survey), in concordance with financial allocations (table 13). Approximately 80% of this inventory time was spent searching for specimens (rather than recording locations, processing specimens, etc.). These person-hours do not reflect total effort expended for each park, as they do not include travel time. The first year parks were within a 2-hour drive of base (Moab, Utah), whereas the second year parks were all between three and eight hours away.

We carried out 272 surveys during the 2002 field season, 232 of which were diurnal VES, with the remaining being night searches and night road drives. We made approximately 1830 individual observations of reptiles and amphibians during survey effort, with a further 163 incidental observations. We documented 31 species: one salamander, nine anuran species, 13 lizard species, and eight snake species. In 2001 we documented one salamander species, six anuran species, one tortoise species, 11 lizard species, and ten snake species, for a total of 29 (Nowak et al, 2002). Information on voucher specimens and photographs collected in 2001 and 2002 will be available from the NCPN data manager upon completion of the accession process.

Sampling effort

We spent 965 person-hours on inventories for reptiles and amphibians between May and September 2001 at eight park units (listed in table 12). The amount of time in person-hours expended on survey effort is summarized in table 12, by park and by survey method.

Table 12. Sampling time in person-hours for amphibian and reptile survey methods during inventories of 8 Northern Colorado Plateau National Park units, May to September 2001. The total sampling time is summarized for each park and each method. Observer time is the amount of time spent looking for specimens, survey time includes time spent processing specimens and in documentation.

PARK	TACS	VES	NIGHT VES	NIGHT DRIVE	TOTAL OBSERVER TIME	TOTAL SURVEY TIME
BRCA	36.9	76.1	0	2.9	**115.9**	**144.9**
CARE	33.7	232.2	6.4	5.7	**278.0**	**347.5**
CEBR	8.0	28.3	3.1	0	**39.4**	**49.2**
FOBU	0	52.2	0	0	**52.2**	**65.3**
GOSP	6.3	29.1	0	.5	**35.9**	**44.9**
PISP	0	23.5	3.0	0	**26.6**	**33.2**
TICA	0	26.3	0	0	**26.4**	**32.9**
ZION	41.87	138.9	9.3	7.4	**197.4**	**246.8**
TOTAL	**126.8**	**606.7**	**21.7**	**16.5**	**771.7**	**964.6**

We spent 453 person-hours on inventories for reptiles and amphibians between March and September 2002 at the 11 park units. The amount of time in person-hours expended on survey effort is summarized in table 13, by park and by survey method.

We spent the most time over both years sampling at ZION, the most diverse of all the park units. ZION also had a larger "target" list of species yet to be documented in 2002 than did the other park units. The smaller park units (TICA, GOSP, FOBU, PISP, and CEBR) received less sampling effort. FOBU received the least amount of effort in 2002, because we only had one target species to locate and were able to do that quickly, after notification by park personnel that the species was active.

During 2002 we only conducted visual encounter surveys (VES) and night drives. Night VES were carried out in locations with accessible riparian areas, during the amphibian breeding season. We only carried out night drives where there were sufficient road surfaces (e.g. at ARCH, COLM, GOSP, and NABR), and when temperatures at dusk exceeded 15^{o}C. Although ZION and BRCA have extensive road surfaces, it was either not feasible to conduct night drives at these parks during 2002 (e.g. at ZION we were frequently in remote areas away from the vehicle) or weather conditions weren't appropriate.

Table 13. Sampling time in person-hours for amphibian and reptile survey methods during inventories of 11 Northern Colorado Plateau National Park units, March to September 2002. The total sampling time is summarized for each park and each method. Observer time is the amount of time spent looking for specimens, survey time includes time spent processing specimens and in documentation.

PARK	VES	NIGHT VES	NIGHT DRIVE	TOTAL OBSERVER TIME	TOTAL SURVEY TIME
ARCH	32.8	0.5	5.2	**38.5**	**47.6**
BRCA	34.4	1.3	0.0	**35.6**	**42.1**
CARE	51.4	0.8	0.0	**52.3**	**61.5**
CEBR	17.8	1.3	0.0	**19.2**	**21.9**
COLM	33.7	0.0	10.3	**44.1**	**52.4**
FOBU	6.7	1.3	0.0	**7.9**	**9.9**
GOSP	17.4	0.2	2.2	**19.8**	**24.3**
NABR	31.2	0.8	3.7	**35.6**	**42.6**
PISP	19.4	2.5	0.0	**21.9**	**23.7**
TICA	9.2	2.5	0.0	**11.6**	**15.1**
ZION	87.4	5.5	0.0	**92.9**	**112.0**
TOTAL	**341.2**	**16.5**	**21.4**	**379.2**	**453.0**

Survey effectiveness

We used capture rate per unit effort to determine survey effectiveness, by taking the number of observations divided by the number of person-hours of survey. Figure 23 shows survey effectiveness across all park units surveyed in 2002. ARCH, CARE, COLM, NABR, PISP, and ZION had reasonably high levels of survey effectiveness, between approximately four to eight species per person-hour. Each of these parks has high abundances of diurnal lizards, and many of the observations consist of one or two very abundant species. The high effectiveness levels for ARCH include a small number of surveys where 50 to 80 bullfrogs, a species that tends to occur at very high densities, were observed in one small locality. CEBR, FOBU, GOSP, and TICA all show an effectiveness of less than one observation per person-hour; these parks are all fairly small in size (ranging from 100 (TICA) to 3318 (FOBU) hectares), and support low abundances of diurnal reptiles. BRCA's low observation rates were due to severe drought conditions experienced during 2002 in what is typically a mesic environment.

Comparisons between survey effectiveness in both years of sampling for the second-year parks are shown in figure 24. The observation rates in 2002 were reduced from 2001 for BRCA, GOSP, PISP and TICA. In BRCA, GOSP and TICA our survey priorities were to locate spring breeding amphibians, and therefore field visits occurred at times when more common species were not observable. In addition, drought conditions in BRCA meant we saw even fewer of these more commonly observed species than would normally be

expected. We also experienced dry and windy conditions at PISP in 2002, conditions not normally advantageous for herpetofauna encounters.

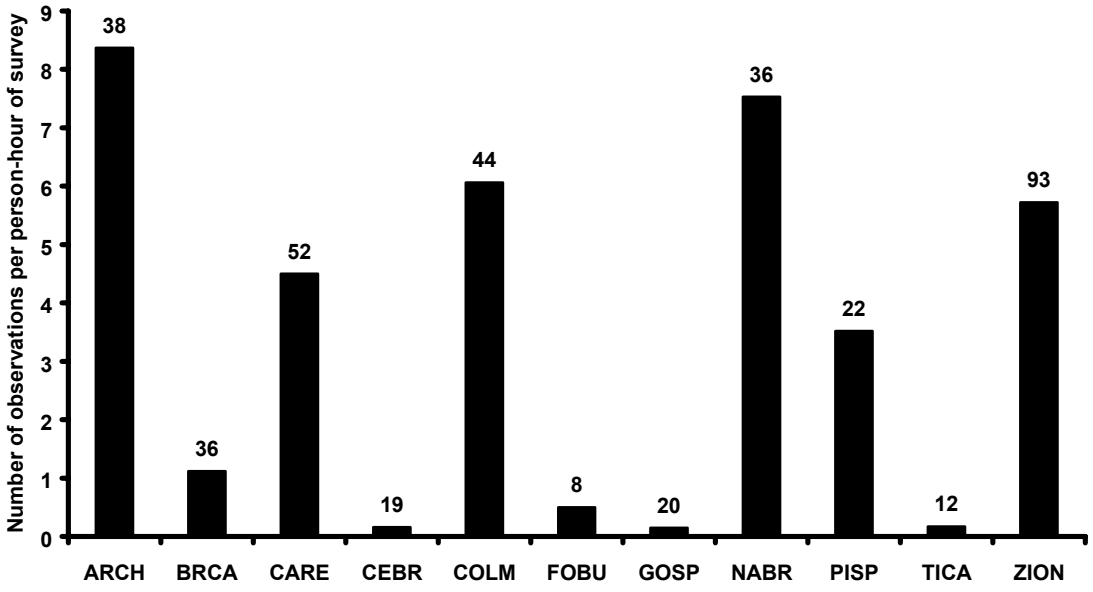

Figure 23. Survey effectiveness in observations per person-hour at each park unit sampled in 2002. Numbers above bars denote number of person-hours expended on inventory effort at that park unit.

It is not biologically meaningful to directly compare effectiveness between years and between parks, as different habitats provided different levels of opportunity for observation. We had different objectives by park, season, and year, and spent much less effort in particular park units in 2002 as a result of quickly locating target species. We also used different survey methods in the two years; in 2001 we expended considerable effort on TACS, which proved to be largely ineffective for herpetofauna observation.

We assessed the effectiveness of difference survey methods used in 2001 for detecting herpetofauna species. Figure 25 shows the number of unique species observed under the different methods used in each park unit. VES alone proved the most effective at locating new species, primarily because particular habitat types and features can receive disproportionate amount of effort according to herpetofauna requirements in relation to other survey methods. TACS alone enabled detection of species in ZION and GOSP that were not located using any other method, but most of the species detected by TACS were also detected using VES. Surprisingly, no species were detected using road driving alone. Probably the most effective method was “other”: incidental sightings and road-kills and other specimens collected by park personnel and held for us.

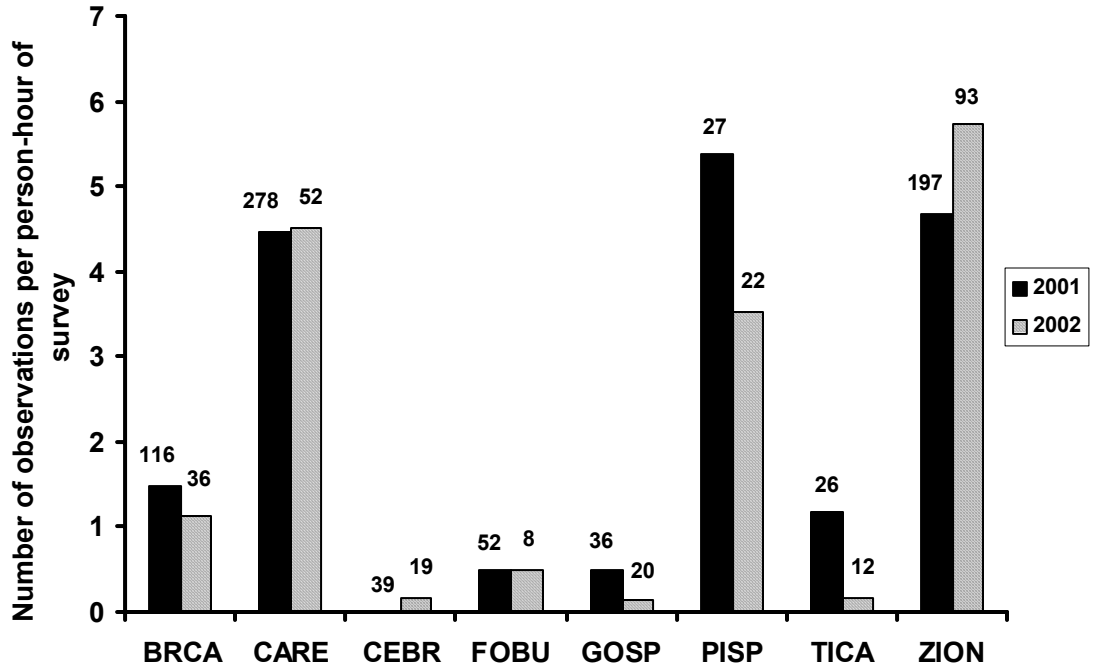

Figure 24. Survey effectiveness in observations per person-hour at second-year parks sampled in 2001 and 2002. Numbers above bars denote number of person-hours expended on inventory effort at that park unit.

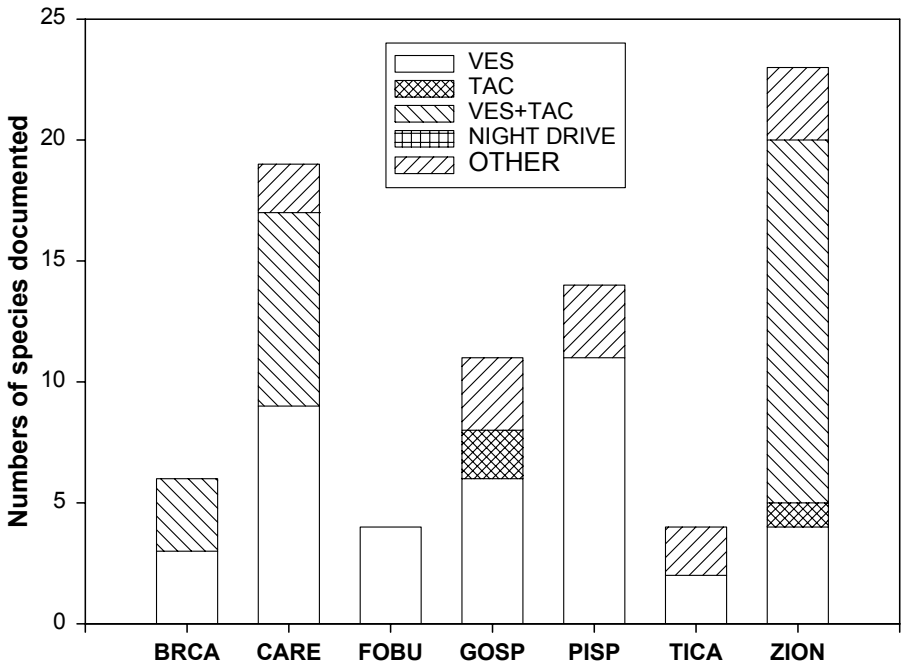

Figure 25. Effectiveness of survey methods at detecting herpetofauna species at NCPN park units. Each category depicts number of species documented only by that method in that park unit. Night drive surveys produced no unique species. Data is from 2001 field season only.

Results by habitat

We assessed survey results according to habitat types sampled within each park unit. Table 14 shows the catch per unit effort within each broad habitat type in each park for 2002. Habitat analyses were not carried out for 2001 data. We sampled from one to eight different habitat types across the NCPN park units in 2002, with differing levels of survey effectiveness. The habitat type most commonly sampled across the NCPN parks was riparian and canyon woodlands, which was present in all park units except FOBU. We only sampled Douglas fir forest habitat in TICA (although Spruce-fir forest can contain Douglas firs). Although survey effort for second-year parks was concentrated around locating target species and we therefore did not systematically sample each available habitat type in each park, we had good coverage of most of the available habitat. Habitat coverage for first-year parks was more evenly distributed. These results cannot be used to assess species abundance by habitat; they can only show level of effort and what we observed.

Table 14. Individual detection rate per unit effort (number of observations per person-hour of effort) by habitat types. Results are presented for 2002 survey effort only. Blanks indicate habitat type not surveyed in park unit; X indicates habitat not present in that park unit.

HABITAT	ARCH	BRCA	CARE	CEBR	COLM	FOBU	GOSP	NABR	PISP	TICA	ZION
BLACKBRUSH SHRUBLANDS	3.36	X		X	X	X	X	X	X	X	2.56
RIPARIAN AND CANYON WOODLANDS	13.82		5.02	0	12.64	X	0	14.17	0	0.3	7.81
WETLANDS	11.2	0	1.6	0	X		0	X	0	X	
GREAT BASIN SAGEBRUSH	X	0		X	4	0.5	0.13	X	X	X	1.71
SALT DESERT SCRUB	9.78	X	1.09	X	5.26	X	X	X	1.1	X	
PINYON-JUNIPER WOODLAND	4.32		3.06	X	4.95	X	X	3.31	0.89	X	3.15
MOUNTAIN MAHOGANY-OAK SHRUB		2	7.43	X	1.33	X	X		X		1.12
PONDEROSA PINE WOODLAND	X	1.35	0	0		X	X	X	X	X	9.02
DOUGLAS FIR FOREST	X				X	X	X		X	0	
SPRUCE-FIR FOREST	X		X	0.42	X	X	X	X	X	0.17	0
ASPEN FOREST	X	0	X	0	X		X	X	X	X	
OTHER	3.61	0		0			2		2		0

Table 15 identifies individual species observed in each broad habitat, by park. These are based on results from both 2001 and 2002. We did not include in this table species for which we do not have habitat information (detected by road-kills, ranger documentation, or other incidental methods), hence the number of species documented is higher than those presented in the table 15. The habitats listed in table 15 reflect the gross habitat type sampled. Although all of our surveys encompassed one habitat type, very frequently species would be located within microhabitats of a differing type. Therefore amphibians may be listed as occurring in a particular habitat in locations where there was a small pool or wetland within the larger habitat type.

Some species are generalists in habitat requirements: the sagebrush lizard (*Sceloporus graciosus*) occurs in all park units except FOBU and CEBR, and in virtually all habitat types. Other species are only found in one particular habitat type, such as the longnose leopard lizard (*Gambelia wislizenii*) that only occurs in lower-elevation shrublands. Despite its name, the western terrestrial garter snake (*Thamnophis elegans*) was only found in association with water. Because we did not systematically sample each habitat type, it is not possible to determine specific habitat associations or distributions.

Table 15. Species observations by gross habitat type sampled within each NCPN park unit. See Appendix 2 for species abbreviations

Park	Type of Habitat	# sp	AMTI	BUMI	BUPU	BUWO	HYAR	PSMA	RAPI	RACA	SPIN	GOAG	CNTI	CNVE	CRCO	CRBI	EUSK	GAWI	PHHE	SCGR	SCMA	SCUN	UROR	UTST	CHBO	COCO	CRVI	HYTO	MAFL	MATA	PICA	THEL	THCY
ARCH	BLACKBRUSH SHRUBLANDS	6											X					X		X		X	X	X									
	PINYON-JUNIPER WOODLAND	4											X									X	X	X									
	RIPARIAN AND CANYON WOODLANDS	9			X	X				X			X					X				X	X	X									X
	SALT DESERT SCRUB	4								X												X		X						X			
	WETLANDS	3								X												X	X										
	OTHER	3			X					X												X											
BRCA	PINYON-JUNIPER WOODLAND	2																	X	X													
	MOUNTAIN MAHOGANY OAK SHRUB	1																		X													
	PONDEROSA PINE WOODLAND	6							X										X	X		X	X								X		
	RIPARIAN AND CANYON WOODLANDS	2																		X												X	
	WETLANDS	1																														X	
CARE	BLACKBRUSH SHRUBLANDS	6											X			X		X		X			X	X									
	GREAT BASIN SAGEBRUSH	9											X			X		X		X		X		X			X			X	X		
	MOUNTAIN MAHOGANY OAK SHRUB	5											X								X		X	X							X			
	PINYON-JUNIPER WOODLAND	10											X	X				X		X	X	X	X	X							X	X		
	RIPARIAN AND CANYON WOODLANDS	12			X	X							X	X				X		X	X	X	X	X			X					X		
	SALT DESERT SCRUB	7											X			X		X		X	X	X		X										
	WETLANDS	2									X											X												
	OTHER	3											X							X												X		
CEBR	SPRUCE-FIR FOREST	1						X																										
COLM	GREAT BASIN SAGEBRUSH	3											X		X									X										
	MOUNTAIN MAHOGANY OAK SHRUB	2																				X		X										
	PINYON-JUNIPER WOODLAND	10				X					X		X	X	X					X		X		X				X		X				
	RIPARIAN AND CANYON WOODLANDS	7				X							X	X	X							X	X	X										
	SALT DESERT SCRUB	2												X										X										
FOBU	ASPEN FOREST	1																														X	
	GREAT BASIN SAGEBRUSH	4						X	X										X													X	
	WETLANDS	3	X						X																							X	

Park	Type of Habitat	# sp	AMTI	BUMI	BUPU	BUWO	HYAR	PSMA	RAPI	RACA	SPIN	GOAG	CNTI	CNVE	CRCO	CRBI	EUSK	GAWI	PHHE	SCGR	SCMA	SCUN	UROR	UTST	CHBO	COCO	CRVI	HYTO	MAFL	MATA	PICA	THEL	THCY
GOSP	GREAT BASIN SAGEBRUSH	8									X		X							X				X		X	X			X	X		
	RIPARIAN AND CANYON WOODLANDS	4	X		X				X																	X							
	OTHER	3			X						X																				X		
NABR	PINYON-JUNIPER WOODLAND	7			X						X			X						X		X	X				X						
	RIPARIAN AND CANYON WOODLANDS	10	X		X	X			X		X			X						X		X	X	X									
PISP	PINYON-JUNIPER WOODLAND	7											X			X			X	X	X	X					X						
	SALT DESERT SCRUB	11											X			X		X	X	X	X	X		X			X			X	X		
	WETLANDS	1									X																						
	OTHER	6	X										X							X	X	X									X		
TICA	RIPARIAN AND CANYON WOODLANDS	1																		X													
	DOUGLAS-FIR FOREST	4																		X					X		X				X		
	MOUNTAIN MAHOGANY OAK SHRUB	1																		X													
	SPRUCE-FIR FOREST	1																									X						
ZION	BLACKBRUSH SHRUBLANDS	6											X			X		X				X		X					X				
	GREAT BASIN SAGEBRUSH	5											X					X		X		X		X									
	MOUNTAIN MAHOGANY OAK SHRUB	8		X									X	X			X			X		X		X						X			
	PINYON-JUNIPER WOODLAND	15		X			X				X	X	X	X		X		X	X	X	X	X		X			X			X			
	PONDEROSA PINE WOODLAND	9	X											X			X		X	X		X	X	X							X		
	RIPARIAN AND CANYON WOODLANDS	15		X	X		X				X		X	X		X		X		X	X	X	X	X			X					X	
	SALT DESERT SCRUB	3											X	X							X												
	WETLANDS	3	X																												X	X	
	OTHER	3																						X			X				X		

Evaluation of effort expended related to completion of inventory

Species accumulation curves (plotted in person-hours) for the NCPN parks surveyed are shown in figure 26 (a-j). CEBR is not included, because only one species was observed there during two years of sampling. For the second-year parks surveyed in 2001 and 2002, continuous accumulation is shown for both years. The number of species shown in the graphs does not necessarily agree with the number reported for that park unit, as we have only included those species we located under field investigations.

Second-year parks

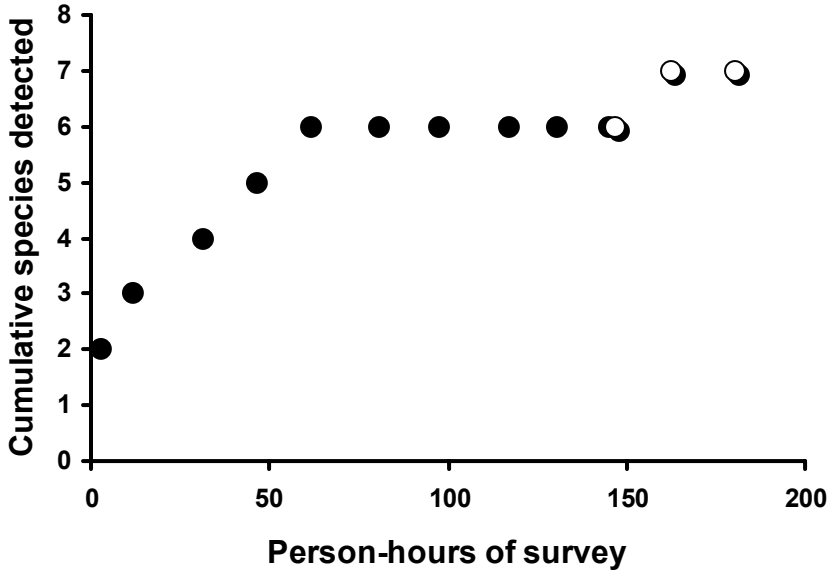

Figure 26a. Species accumulation at BRCA after 2001 and 2002 field seasons. Black spots indicate accumulation in 2001; white spots indicate accumulation in 2002.

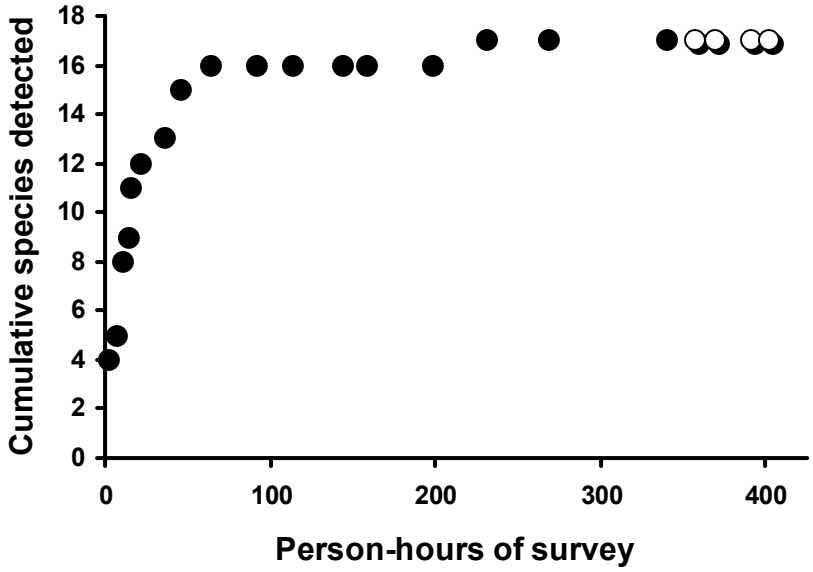

Figure 26b. Species accumulation at CARE after 2001 and 2002 field seasons. Black spots indicate accumulation in 2001; white spots indicate accumulation in 2002.

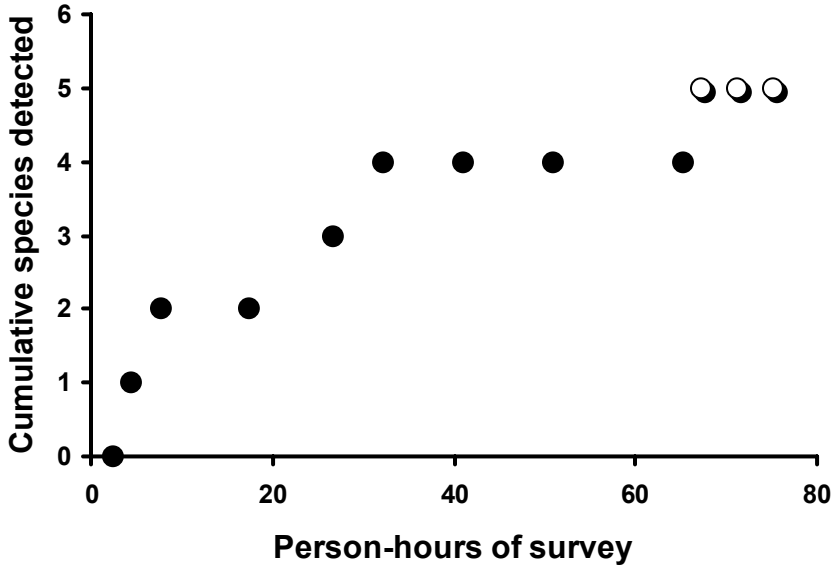

Figure 26c. Species accumulation at FOBU after 2001 and 2002 field seasons. Black spots indicate accumulation in 2001; white spots indicate accumulation in 2002.

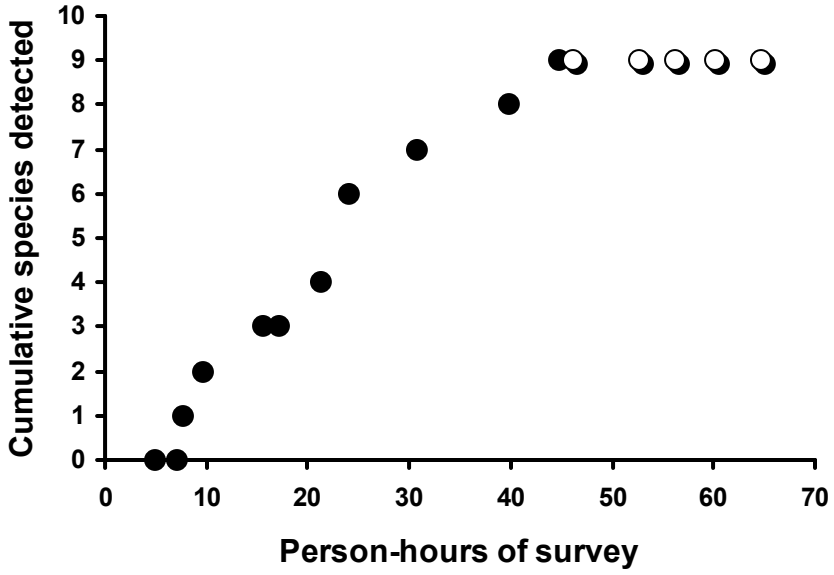

Figure 26d. Species accumulation at GOSP after 2001 and 2002 field seasons. Black spots indicate accumulation in 2001; white spots indicate accumulation in 2002.

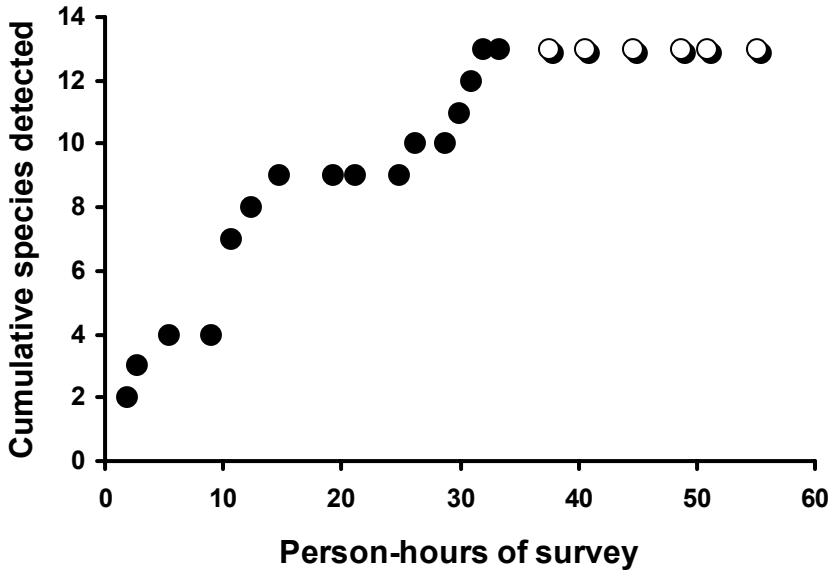

Figure 26e. Species accumulation at PISP after 2001 and 2002 field seasons. Black spots indicate accumulation in 2001; white spots indicate accumulation in 2002.

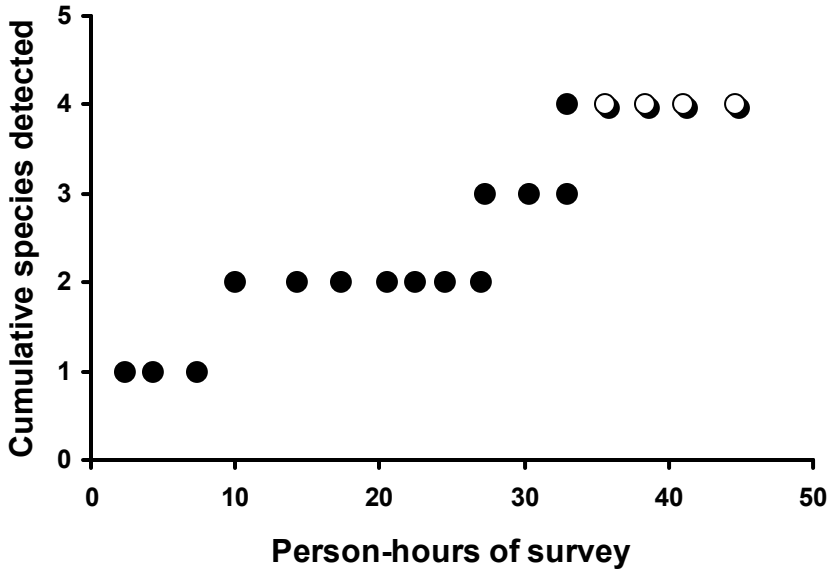

Figure 26f. Species accumulation at TICA after 2001 and 2002 field seasons. Black spots indicate accumulation in 2001; white spots indicate accumulation in 2002.

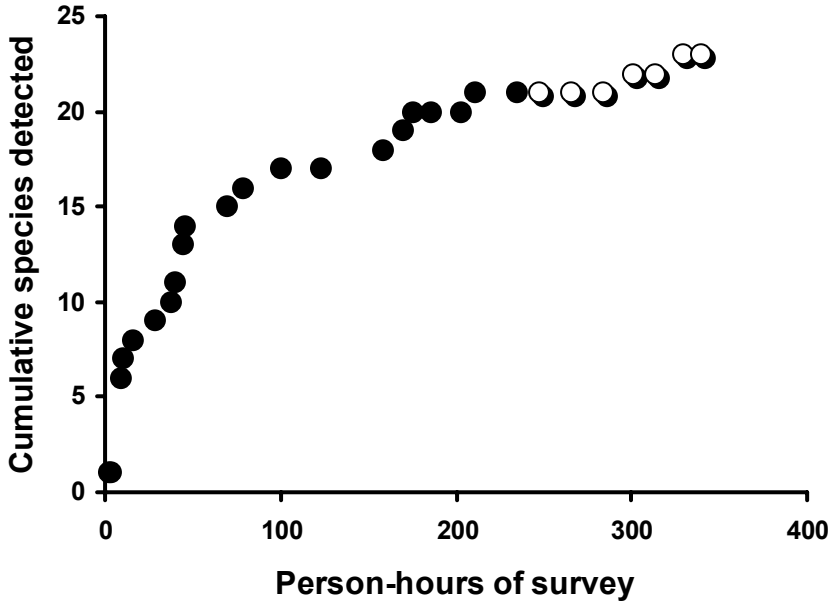

Figure 26g. Species accumulation at ZION after 2001 and 2002 field seasons. Black spots indicate accumulation in 2001; white spots indicate accumulation in 2002.

First-year parks:

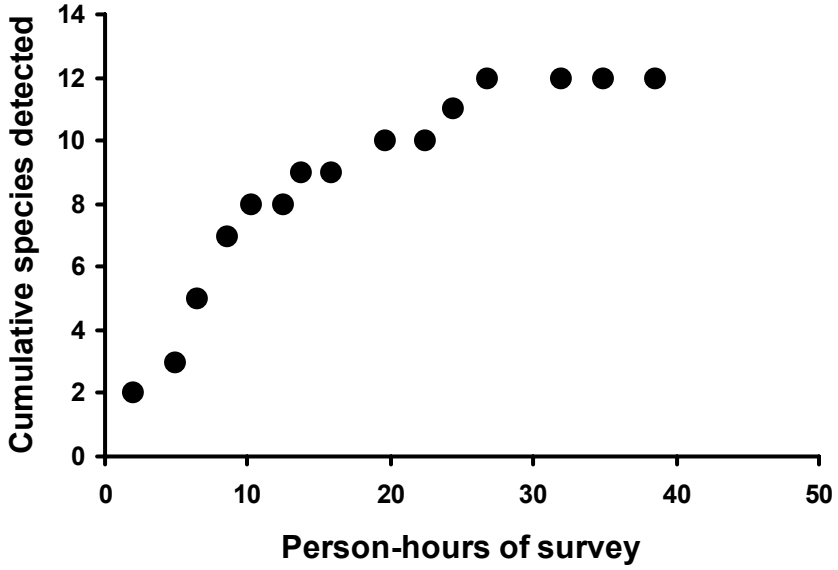

Figure 26h. Species accumulation at ARCH after 2002 field season

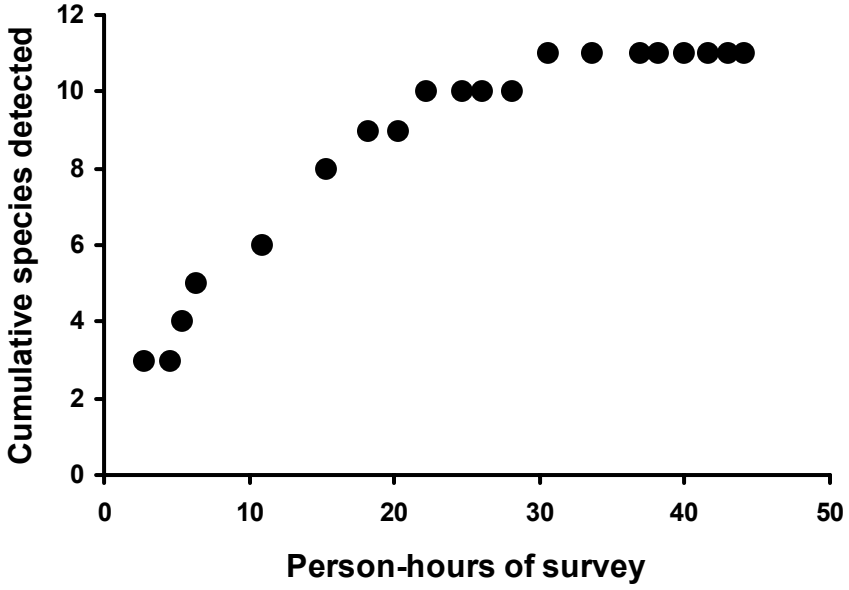

Figure 26i. Species accumulation at COLM after 2002 field season

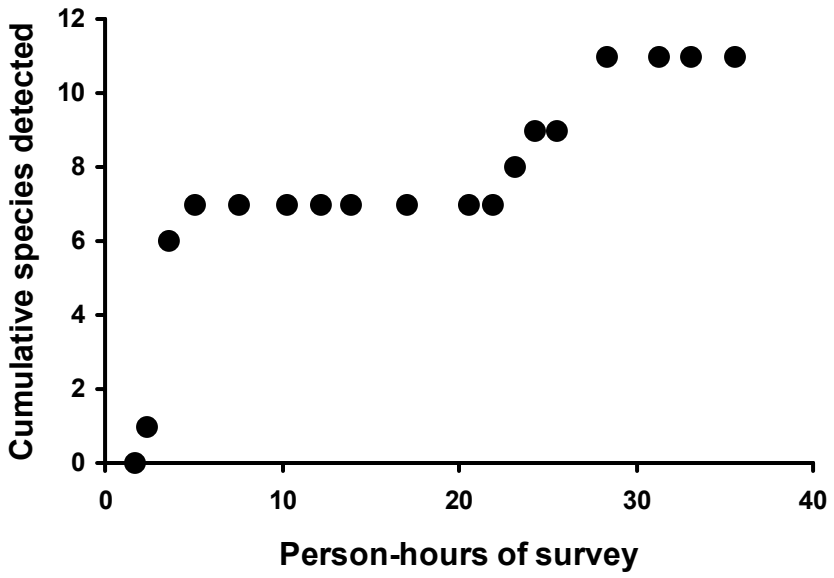

Figure 26j. Species accumulation at NABR after 2002 field season

The accumulation curves rise sharply within the first 50 person-hours of survey effort, during which time we have generally located all of the common and easy-to-find species. After that, the curves tend to level out, and it requires much more effort, e.g. as much as 60 person-hours (ZION) or more (100 person-hours in CARE), to locate another species. The curves reach an asymptote much more slowly in the smaller park units, where effort was divided into shorter time periods (two or three days) than larger park units (five to seven days).

The asymptotes shown in the curves are misleading, as they suggest that we have reached survey completeness. This is not the case for most of the parks, as comparisons with master species lists show (below). Rather, we have reached a level where we have detected most or all of the common species using the current survey methods. The curves for CARE and ZION show that even when a seemingly stable asymptote is reached, there are still species left to be detected.

The accumulation curves of the second-year parks show very little if any increase during 2002. There are two reasons for this, firstly that the remaining as yet to be documented species are secretive or otherwise difficult to locate, and secondly that the drought conditions prevented us from seeing much of anything other than the abundant diurnal lizards. Even sightings of common snake species, such as the gopher snake (*Pituophis catenifer*), were reduced in 2002.

Assessment of inventory completeness

To estimate inventory completeness, we compared the number of species documented against the master list of potentially occurring species for each park unit. These lists have evolved over the course of this study as our knowledge base increased (see methods section for an explanation of how the lists have been refined). Tables 16 and 17 show percentage completeness for each taxon in each of the 11 park units. The master list used for the standard in Table 16 contains those species that we know to occur in the parks from direct observation or other reliable evidence, or are known to occur in the vicinity of the park and are found in similar habitats as those available within the park. The master list used to estimate percentage completeness in Table 17 also includes those species which might occur in the park, but for which we have no definite evidence of their occurrence. Appendix 1 contains both definitive and watch lists of herpetofauna species for each of the 11 park units surveyed in 2001 and 2002.

Table 16. Estimated percentage inventory completeness for 11 NCPN park units surveyed during 2001 and 2002. Percentages are based on number of species documented under current inventory effort against estimated species on master list (Appendix 1). Last column shows number of target species in all taxa groups. Asterisks (*) denote parks with one year of survey effort, all the rest have received two years.

PARK	AMPHIBIANS	LIZARDS	SNAKES	OTHER	OVERALL	NUMBER OF SPECIES
ARCH	67%	89%	25%		61%*	23
BRCA	33%	67%	50%		54%	13
CARE	67%	100%	71%		83%	23
CEBR	100%	--	--		100%	1
COLM	33%	78%	38%		52%*	23
FOBU	100%	100%	100%		100%	5
GOSP	80%	100%	100%		93%	14
NABR	100%	63%	25%		67%*	18
PISP	100%	89%	60%		82%	17
TICA	--	100%	100%		100%	4
ZION	83%	80%	83%	100%	82%	34

***First-year parks**

Table 17. Estimated percentage inventory completeness for 11 NCPN park units surveyed during 2001 and 2002. Percentages are based on number of species documented under current inventory effort against estimated species on master list, including those species that may reasonably be expected to occur in the park, but for which we have no definitive documentation, listed as "watch" species in Appendix 1. Last column shows number of target species in all taxa groups. Asterisks (*) denote parks with one year of survey effort, all the rest have received two years.

PARK	AMPHIBIANS	LIZARDS	SNAKES	OTHER	OVERALL	NUMBER OF SPECIES
ARCH	57%	80%	22%		54%*	26
BRCA	25%	67%	40%		47%	15
CARE	67%	83%	71%		76%	25
CEBR	33%	0%	0%		10%	10
COLM	33%	78%	38%		52%*	23
FOBU	100%	50%	100%		83%	6
GOSP	80%	100%	57%		76%	17
NABR	86%	56%	11%		48%*	25
PISP	75%	67%	43%		61%	23
TICA	0%	33%	50%		40%	10
ZION	83%	80%	83%	100%	82%	34

***First-year parks**

Based on the definitive master species list, we estimate that overall inventory completeness for the 11 parks is 79%, with 87% completeness in second-year parks and 60% in first year parks. Figure 27 shows estimated survey completeness by number of species yet to be detected in each park unit.

Adding the watch list species to the master list for comparison brings the overall completeness to 58% (59% for second-year parks, 54% for first-year parks). There are two considerations that should be noted: 1) the number of species in question is small, therefore the inclusion of one or two species can dramatically affect the percentage completeness, and 2) in parks for which we already have considerable information (e.g. ZION and COLM), the percentage completeness doesn't change because there are no additions to the list. Using a 90% level of completeness as a benchmark for herpetofauna is arbitrary and not particularly meaningful, as it can frequently be impossible to reach 90% with the presence of only four or five species. A good example of this is FOBU: with the five species known to be present and documented by us during this inventory, we have reached 100%. However, if we include the sagebrush lizard *Sceloporus graciosus* in the list because there is reason to believe it could occur in the park, the percentage completeness drops to 50% for lizards, and to less than 85% overall. CEBR, with only one known species, is also a good example. We only need to add one possible species to the master list to reduce our completeness by 50%.

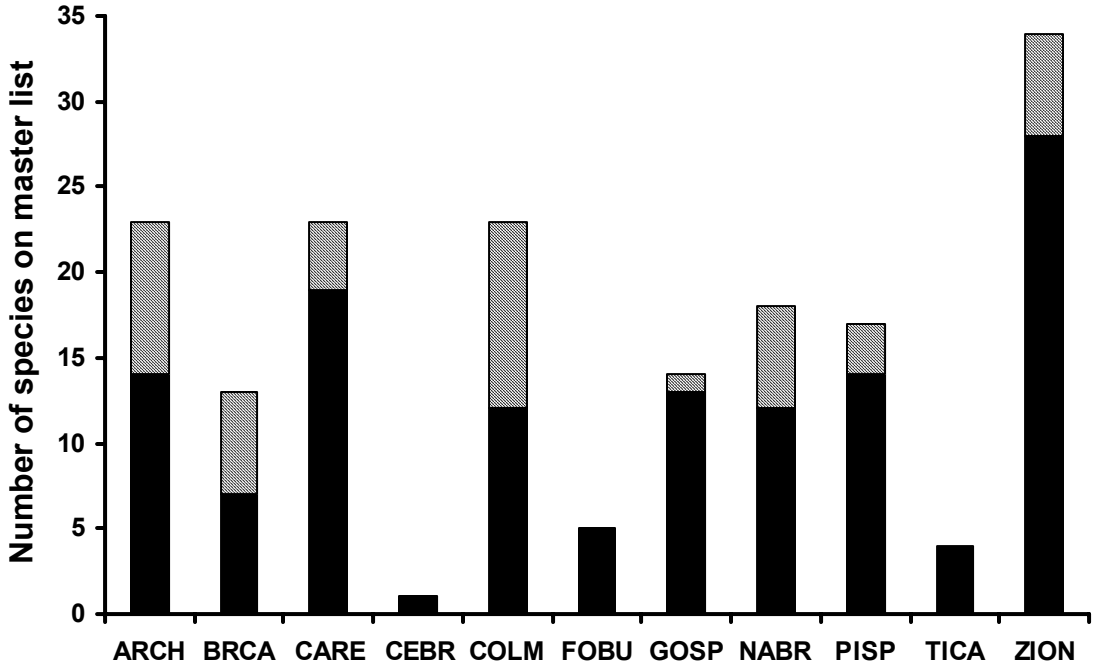

Figure 27. Estimated survey completeness of NCPN park units at the end of the 2002 field season. Black segments indicate species documented under current inventory; hatched segments indicate estimated species on master list yet to be detected.

We have shown estimated inventory completeness in relation to effort in person-hours for the 11 parks surveyed (figure 28). There appear to be three separate groupings: the first-year parks, the small second-year park units, and the larger parks (ZION, BRCA, CARE). The first-year parks have had much less effort than the other park units, and show a lower completeness. The smaller second-year units show a high level of completeness, with minimal (under 100 person-hours) effort. The larger parks show considerably more effort, but are not yet at the target levels of completeness.

There are many species about which we know very little, e.g. the night lizard *Xantusia vigilis*. We have located only two records of this species east of the Colorado River, one an NPS voucher from NABR (1990) and one published account (Tanner, 1958), although it could quite feasibly occur everywhere (T. Persons, pers. comm.). Another example is the chuckwalla in CARE, for which we only have published accounts from pre-Lake Powell days (Woodbury, 1958, 1959). The scope of the current inventory does not allow for sufficient research into these and other highly secretive, specialized, and difficult to locate species.

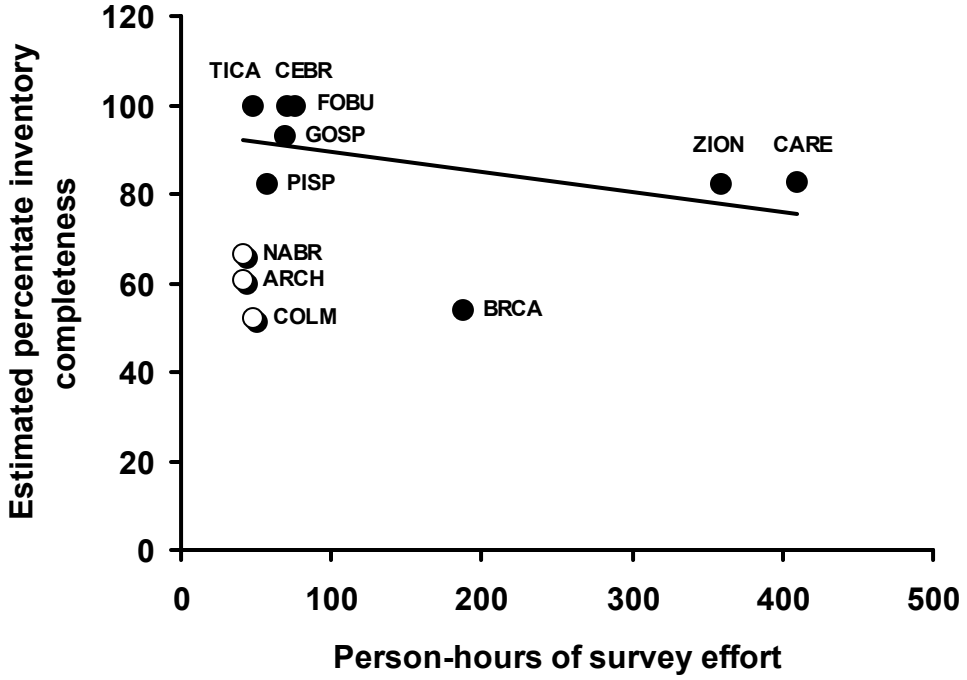

Figure 28. Estimated inventory completeness in relation to effort for the 11 NCPN park units surveyed for amphibians and reptiles. Black spots indicate parks surveyed over two field seasons, in 2001 and 2002; white spots indicate parks surveyed during one season only in 2002.

Recommendations for future inventory work

It is clear that there is still much to learn about the herpetofauna of the national parks across the Northern Colorado Plateau. Two years is insufficient to provide sufficient coverage across such remote, rugged and discontinuous terrain. The Colorado Plateau offers innumerable opportunities to investigate the effects of landscape features on the distribution and abundance of herpetofauna species, but this is well beyond the scope of this inventory. However, each of these landscape features has the potential to mask our understanding of species and their distribution, and therefore the results of this inventory should only be considered as preliminary.

We recommend that further inventory work be conducted in the NCPN parks that have low levels of pre-existing information, i.e. CEBR, GOSP, PISP, TICA, and should include BLCA, CURE, and DINO. More effort should be expended to locating the northern leopard frog (*Rana pipiens*) in parks where they have not yet been documented (e.g. ARCH, CARE, COLM, and ZION), as this species is a potentially crucial indicator of environmental health. Despite its great attraction and levels of visitation and research, there is still very little known about the herpetofauna of CANY. The mystery of the unidentified spadefoot toads to the east of the Colorado River should be cleared up, preferably in collaboration with genetic research. The status of the longnose leopard

lizard *Gambelia wislizenii* in COLM, apparently once abundant but now rarely seen, should also be investigated.

The methods for further inventory should be tailored to fit the target species and the parks in question. We do not recommend the use of randomly located plots for inventory purposes, this method is not effective for locating much other than common diurnal species than can be more quickly located using more general surveys. Rather, we recommend that further inventory effort be structured around biological requirements of target species. We had very good results in 2002 in finding more difficult to observe species by only visiting specific sites under specific conditions (e.g. boreal chorus frogs *Pseudacris maculata* at FOBU in April, in the snow).

Observations and collections by Park Service personnel have proven crucial to the success of this inventory, especially for uncommon or secretive species that generally remain undetected during short field visits (Nowak et al., 2003). We cannot overemphasize the value of local knowledge and presence; serendipity (right place, right time) plays a large role in the success of herpetofauna inventory, and it is not possible for a small survey crew to always be in those places when necessary. Increased involvement of the park staff in future inventory effort should be established, with training provided if required. Ideally, future inventory would involve field survey personnel that live within a park unit, thereby ensuring local presence and eliminating extensive travel.

Recommendations for long-term monitoring

Herpetofauna inventories of the NCPN national park units are not yet completed, and it is therefore not feasible to make extensive long-term monitoring recommendations at this point. However, we are able to put forward some items for consideration.

It is well documented that amphibians make ideal “vital signs” of ecosystem health and stability (e.g. Heyer et al., 1994). They tend to be explosive breeders, that is, they appear at a suitable breeding site *en masse*, frequently in response to an environmental event, such as rainfall. They are vocal, produce visible and countable eggs, and can easily be differentiated. It is therefore extremely easy to establish effective monitoring programs for amphibians using volunteers with limited expertise and training. In response to global amphibian declines and an increased profile of amphibians as bioindicators, the DOI has established a research and monitoring program (Amphibian Research and Monitoring Initiative, ARMI) to develop amphibian monitoring protocols and priorities and to establish monitoring programs. The US Geological Survey is the lead on this program. One part of this is the North American Amphibian Monitoring Program, based at Patuxent Wildlife Research Center and operated nationally, widely using volunteer manpower. Another project under ARMI is already in progress in CANY. We recommend the NPS take a proactive role in supporting and extending this program to other regions of the Colorado Plateau.

Reptile species, on the other hand, are extremely difficult to locate, especially under sub-optimal weather conditions. These species are very specialized, only active during certain

times of day and in certain seasons of the year, and even then they can be cryptic, secretive, or otherwise difficult to observe. Species frequently occur in low abundances, and it is difficult to make population density assessments when it isn't possible to determine if they are there and not being observed, or if they are not there at all. Diurnal lizards, such as the sagebrush lizard *Sceloporus graciosus* and the side-blotched lizard *Uta stansburiana*, are exceptions. These can occur at very high densities, and are highly visible where present. Therefore, rather than focusing on the rare and illusive reptiles across the plateau, it is much more time and resource effective to concentrate on a small number of very abundant species that occur in a variety of habitat types. Resources can then be concentrated on park-specific species of interest or concern, such as the leopard lizard in COLM and the spadefoots within the Southeast Utah Group of national parks.

Monitoring methods typically used for other taxa, such as time-and area-constrained searches and point counts, are not effective for herpetofauna in these arid and complex environments (Nowak et al., 2002, Nowak et al., 2003). We recommend periodic complete inventories, to assess changes in relative abundance and distribution over time.

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Appendix 1

Master list of reptile and amphibian species in 11 NCPN park units surveyed in 2001 and 2002. Species marked with an asterisk (*) were documented under current inventory effort. Those species labeled with **(W)** are those that may occur in park unit but for which we have no verifiable evidence.

ARCHES NATIONAL PARK	
AMPHIBIANS	
Tiger Salamander	*Ambystoma tigrinum*
*Red-spotted Toad	*Bufo punctatus*
*Woodhouse's Toad	*Bufo woodhousii*
Northern Leopard Frog	*Rana pipiens*
*Bullfrog	*Rana catesbeiana*
*Great Basin Spadefoot	*Spea intermontana*
Canyon Treefrog **(W)**	*Hyla arenicolor*
LIZARDS	
*Western Whiptail	*Cnemidophorus tigris*
Plateau Striped Whiptail	*Cnemidophorus velox*
*Western Collared Lizard	*Crotaphytus collaris*
*Longnose Leopard Lizard	*Gambelia wislizenii*
*Mountain Short-horned Lizard	*Phrynosoma hernandesi*
*Sagebrush Lizard	*Sceloporus graciosus*
*Eastern Fence Lizard	*Sceloporus undulatus*
*Tree Lizard	*Urosaurus ornatus*
*Side-blotched Lizard	*Uta stansburiana*
Utah Night Lizard **(W)**	*Xantusia vigilis utahensis*
SNAKES	
Midget Faded Rattlesnake	*Crotalus viridis concolor*
Great Plains Rat Snake	*Elaphe gutatta emoryi*
Night Snake	*Hypsiglena torquata*
Milk Snake **(W)**	*Lampropeltis triangulum*
Gopher Snake	*Pituophis catenifer*
Southwestern Blackhead Snake	*Tantilla hobartsmithi*
*Striped Whipsnake	*Masticophis taeniatus*
*Blackneck Garter Snake	*Thamnophis cyrtopsis*
Western Terrestrial Garter Snake	*Thamnophis elegans*

BRYCE CANYON NATIONAL PARK	
AMPHIBIANS	
Tiger Salamander	*Ambystoma tigrinum*
Western Toad **(encroaching, but not in park unit)**	*Bufo boreas*
Woodhouse's Toad **(W)**	*Bufo woodhousii*
*Northern Leopard Frog	*Rana pipiens*
Great Basin Spadefoot	*Spea intermontana*
LIZARDS	
Western Whiptail	*Cnemidophorus tigris*
Western Skink	*Eumeces skiltonianus*
*Mountain Short Horned Lizard	*Phrynosoma hernandesi*
*Sagebrush Lizard	*Sceloporus graciosus*
*Eastern Fence Lizard	*Sceloporus undulatus*
*Tree Lizard	*Urosaurus ornatus*
SNAKES	
Great Basin Rattlesnake	*Crotalus viridis lutosus*
Ringneck Snake **(W)**	*Diadophis punctatus*
Striped Whipsnake	*Masticophis taeniatus*
*Gopher Snake	*Pituophis catenifer*
*Western Terrestrial Garter Snake	*Thamnophis elegans*

CAPITOL REEF NATIONAL PARK	
AMPHIBIANS	
Tiger Salamander	*Ambystoma tigrinum*
*Red-spotted Toad	*Bufo punctatus*
*Woodhouse's Toad	*Bufo woodhousii*
*Canyon Treefrog	*Hyla arenicolor*
Northern Leopard Frog	*Rana pipiens*
*Great Basin Spadefoot	*Spea intermontana*
LIZARDS	
*Western Whiptail	*Cnemidophorus tigris*
*Plateau Striped Whiptail	*Cnemidophorus velox*
*Great Basin Collared Lizard	*Crotaphytus bicinctores*
*Longnose Leopard Lizard	*Gambelia wislizenii*
*Mountain Short Horned Lizard	*Phrynosoma hernandesi*
Chuckwalla **(W)**	*Sauromalus obesus*
*Sagebrush Lizard	*Sceloporus graciosus*
*Desert Spiny Lizard	*Sceloporus magister*
*Eastern Fence Lizard	*Sceloporus undulatus*
*Tree Lizard	*Urosaurus ornatus*
*Side-blotched Lizard	*Uta stansburiana*
Utah Night Lizard **(W)**	*Xantusia vigilis utahensis*
SNAKES	
*Midget Faded Rattlesnake	*Crotalus viridis concolor*
Night Snake	*Hypsiglena torquata*
*Common Kingsnake	*Lampropeltis getula*
*Striped Whipsnake	*Masticophis taeniatus*
*Gopher Snake	*Pituophis catenifer*
Southwestern Blackhead Snake	*Tantilla hobartsmithi*
*Western Terrestrial Garter Snake	*Thamnophis elegans*

CEDAR BREAKS NATIONAL MONUMENT	
AMPHIBIANS	
Tiger Salamander **(W)**	*Ambystoma tigrinum*
*Boreal Chorus Frog	*Pseudacris maculata*
Northern Leopard Frog **(W)**	*Rana Pipiens*
LIZARDS	
Western Skink **(W)**	*Eumeces skiltonianus*
Mountain Short Horned Lizard **(W)**	*Phrynosoma hernandesi*
Sagebrush Lizard **(W)**	*Sceloporus graciosus*
SNAKES	
Sonoran Mountain Kingsnake **(W)**	*Lampropeltis pyromelana*
Milk Snake **(W)**	*Lampropeltis triangulum*
Gopher Snake **(W)**	*Pituophis catenifer*
Western Rattlesnake **(W)**	*Crotalus viridis*

COLORADO NATIONAL MONUMENT	
AMPHIBIANS	
Tiger Salamander	*Ambystoma tigrinum*
Red-spotted Toad	*Bufo punctatus*
*Woodhouse's Toad	*Bufo woodhousii*
Canyon Treefrog	*Hyla arenicolor*
*Great Basin Spadefoot	*Spea intermontana*
Northern Leopard Frog	*Rana pipiens*
LIZARDS	
*Western Collared Lizard	*Crotaphytus collaris*
*Western Whiptail	*Cnemidophorus tigris*
*Plateau Striped Whiptail	*Cnemidophorus velox*
Longnose Leopard Lizard	*Gambelia wislizenii*
Mountain Short Horned Lizard	*Phrynosoma hernandesi*
*Sagebrush Lizard	*Sceloporus graciosus*
*Eastern Fence Lizard	*Sceloporus undulatus*
*Tree Lizard	*Urosaurus ornatus*
*Side-blotched Lizard	*Uta stansburiana*
SNAKES	
*Western Rattlesnake	*Crotalus viridis*
Great Plains Rat Snake	*Elaphe gutatta emoryi*
*Night Snake	*Hypsiglena torquata*
Milk Snake	*Lampropeltis triangulum*
*Striped Whipsnake	*Masticophis taeniatus*
Gopher Snake	*Pituophis catenifer*
Southwestern Blackhead Snake	*Tantilla hobartsmithi*
Western Terrestrial Garter Snake	*Thamnophis elegans*

FOSSIL BUTTE NATIONAL MONUMENT	
AMPHIBIANS	
*Tiger Salamander	*Ambystoma tigrinum*
*Boreal Chorus Frog	*Pseudacris maculata*
*Northern Leopard Frog	*Rana pipiens*
LIZARDS	
*Mountain Short Horned Lizard	*Phrynosoma hernandesi*
Sagebrush Lizard **(W)**	*Sceloporus graciosus*
SNAKES	
*Western Terrestrial Garter Snake	*Thamnophis elegans*

GOLDEN SPIKE NATIONAL HISTORIC SITE	
AMPHIBIANS	
*Tiger Salamander	*Ambystoma tigrinum*
*Woodhouse's Toad	*Bufo woodhousii*
Boreal Chorus Frog **(W)**	*Pseudacris maculata*
*Northern Leopard Frog	*Rana pipiens*
*Great Basin Spadefoot	*Spea intermontana*
LIZARDS	
*Western Whiptail	*Cnemidophorus tigris*
*Western Skink	*Eumeces skiltonianus*
*Desert Horned Lizard	*Phrynosoma platyrhinos*
*Sagebrush Lizard	*Sceloporus graciosus*
*Side-blotched Lizard	*Uta stansburiana*
SNAKES	
Rubber Boa **(W)**	*Charina bottae*
*Yellow-bellied Racer	*Coluber constrictor mormon*
*Great Basin Rattlesnake	*Crotalus viridis lutosus*
*Striped Whipsnake	*Masticophis taeniatus*
*Gopher Snake	*Pituophis catenifer*
Western Terrestrial Garter Snake **(W)**	*Thamnophis elegans*
Common Garter Snake **(W)**	*Thamnophis sirtalis*

NATURAL BRIDGES NATIONAL MONUMENT	
AMPHIBIANS	
*Tiger Salamander	*Ambystoma tigrinum*
*Red-spotted Toad	*Bufo punctatus*
*Woodhouse's Toad	*Bufo woodhousii*
*Canyon Tree Frog	*Hyla arenicolor*
*Northern Leopard Frog	*Rana pipiens*
*Great Basin Spadefoot	*Spea intermontana*
New Mexico Spadefoot **(W)**	*Spea multiplicata*
LIZARDS	
Western Whiptail **(W)**	*Cnemidophorus tigris*
*Plateau Striped Whiptail	*Cnemidophorus velox*
Western Collared Lizard	*Crotaphytus collaris*
*Mountain Short-horned Lizard	*Phrynosoma hernandesi*
*Sagebrush Lizard	*Sceloporus graciosus*
*Eastern Fence Lizard	*Sceloporus undulatus*
*Tree Lizard	*Urosaurus ornatus*
*Side-blotched Lizard	*Uta stansburiana*
Utah Night Lizard	*Xantusia vigilis utahensis*
SNAKES	
Glossy Snake **(W)**	*Arizona elegans*
*Western Rattlesnake	*Crotalus viridis*
Night Snake	*Hypsiglena torquata*
Common Kingsnake **(W)**	*Lampropeltis getula*
Striped Whipsnake	*Masticophis taeniatus*
Gopher Snake	*Pituophis catenifer*
Longnose Snake **(W)**	*Rhinocheilus lecontei*
Blackneck Garter Snake **(W)**	*Thamnophis cyrtopsis*
Western Terrestrial Garter Snake **(W)**	*Thamnophis elegans*

PIPE SPRING NATIONAL MONUMENT	
AMPHIBIANS	
*Tiger Salamander	*Ambystoma tigrinum*
Red-spotted Toad **(W)**	*Bufo punctatus*
*Woodhouse's Toad	*Bufo woodhousii*
*Great Basin Spadefoot	*Spea intermontana*
LIZARDS	
*Western Whiptail	*Cnemidophorus tigris*
Plateau Striped Whiptail **(W)**	*Cnemidophorus velox*
*Great Basin Collared Lizard	*Crotaphytus bicinctores*
Western Skink **(W)**	*Eumeces skiltonianus*
*Longnose Leopard Lizard	*Gambelia wislizenii*
*Mountain Short-horned Lizard	*Phrynosoma hernandesi*
Desert Horned Lizard **(W)**	*Phrynosoma platyrhinos*
*Sagebrush Lizard	*Sceloporus graciosus*
*Desert Spiny Lizard	*Sceloporus magister*
*Eastern Fence Lizard	*Sceloporus undulatus*
Tree Lizard	*Urosaurus ornatus*
*Side-blotched Lizard	*Uta stansburiana*
SNAKES	
*Great Basin Rattlesnake	*Crotalus viridis lutosus*
Common Kingsnake	*Lampropeltis getula*
*Striped Whipsnake	*Masticophis taeniatus*
*Gopher Snake	*Pituophis catenifer*
Longnose Snake **(W)**	*Rhinocheilus lecontei*
Western Patchnose Snake **(W)**	*Salvadora hexalepis*
Western Terrestrial Garter Snake	*Thamnophis elegans*

TIMPANOGOS CAVE NATIONAL MONUMENT	
AMPHIBIANS	
Columbia Spotted Frog **(W)**	*Rana luteiventris*
LIZARDS	
Western Skink **(W)**	*Eumeces skiltonianus*
Mountain Short-horned Lizard **(W)**	*Phrynosoma hernandesi*
*Sagebrush Lizard	*Sceloporus graciosus*
SNAKES	
*Rubber Boa	*Charina bottae*
*Great Basin Rattlesnake	*Crotalus viridis lutosus*
*Gopher Snake	*Pituophis catenifer*
Western Terrestrial Garter Snake **(W)**	*Thamnophis elegans*

ZION NATIONAL PARK	
AMPHIBIANS	
*Tiger Salamander	*Ambystoma tigrinum*
*Arizona Toad	*Bufo microscaphus*
*Red-spotted Toad	*Bufo punctatus*
*Canyon Treefrog	*Hyla arenicolor*
Northern Leopard Frog	*Rana pipiens*
*Great Basin Spadefoot	*Spea intermontana*
TORTOISES	
*Desert Tortoise	*Gopherus agassizii*
LIZARDS	
*Western Whiptail	*Cnemidophorus tigris*
*Plateau Striped Whiptail	*Cnemidophorus velox*
Utah Banded Gecko	*Coleonyx variegatus utahensis*
*Great Basin Collared Lizard	*Crotaphytus bicinctores*
*Western Skink	*Eumeces skiltonianus*
*Longnose Leopard Lizard	*Gambelia wislizenii*
Gila Monster	*Heloderma suspectum*
*Mountain Short Horned Lizard	*Phrynosoma hernandesi*
Desert Horned Lizard	*Phrynosoma platythinos*
*Chuckwalla	*Sauromalus obesus*
*Sagebrush Lizard	*Sceloporus graciosus*
*Desert Spiny Lizard	*Sceloporus magister*
*Eastern Fence Lizard	*Sceloporus undulatus*
*Tree Lizard	*Urosaurus ornatus*
*Side-blotched Lizard	*Uta stansburiana*
SNAKES	
*Great Basin Rattlesnake	*Crotalus viridis lutosus*
*Ringneck Snake	*Diadophis punctatus*
Night Snake	*Hypsiglena torquata*
*Common Kingsnake	*Lampropeltis getula*
*Sonoran Mountain Kingsnake	*Lampropeltis pyromelana*
*Coachwhip	*Masticophis flagellum*
*Striped Whipsnake	*Masticophis taeniatus*
*Gopher Snake	*Pituophis catenifer*
*Mojave Patch-nosed Snake	*Salvadora hexalepis*
*Ground Snake	*Sonora semiannulata*
*Wandering Garter Snake	*Thamnophis elegans vagrans*
Lyre Snake	*Trimorphodon biscutatus*

Appendix 2

List of scientific and common names and species abbreviations used in text. Alternate common and scientific names refer to recently changed nomenclature still in use, or to subspecies. Nomenclature is from Collins and Taggart (2002) except where marked with and asterisk (*); these are from the Committee on Standard English and Scientific Names (2000).

Species abbreviation	Common name	Scientific name	Alternate common names	Alternate scientific names
AMTI	Tiger salamander	*Ambystoma tigrinum*		
BUBO	Western Toad	*Bufo boreas*	Boreal Toad	*Bufo boreas boreas*
BUMI	Arizona Toad	*Bufo microscaphus*		
BUPU	Red-spotted toad	*Bufo punctatus*		
BUWO	Woodhouse's Toad	*Bufo woodhousii*		
CHBO	Rubber Boa	*Charina bottae*		
CNTI	Western Whiptail	*Cnemidophorus tigris*		
CNVE	Plateau Striped Whiptail	*Cnemidophorus velox*		
COCO	Western Yellow-bellied Racer	*Coluber constrictor mormon**		
CRBI	Great Basin Collared Lizard*	*Crotaphytus bicinctores*	Desert Collared Lizard	
CRCO	Western Collared Lizard	*Crotaphytus collaris*		
CRVI	Western Rattlesnake	*Crotalus viridis**		
CRVI-CO	Midget Faded Rattlesnake	*Crotalus viridis concolor**		
CRVI-LU	Great Basin Rattlesnake	*Crotalus viridis lutosus**		
EUSK	Western Skink	*Eumeces skiltonianus*		
GAWI	Longnose Leopard Lizard	*Gambelia wislizenii*		
GOAG	Desert Tortoise	*Gopherus agassizii*		
HYAR	Canyon Treefrog	*Hyla arenicolor*		
HYTO	Night Snake	*Hypsiglena torquata*		
MAFL	Coachwhip	*Masticophis flagellum*		
MATA	Striped Whipsnake	*Masticophis taeniatus*		
PHHE	Mountain Short-horned Lizard	*Phrynosoma hernandesi*		*Phrynosoma douglassi*
PICA	Gopher Snake	*Pituophis catenifer*		*Pituophis melanoleucus*
PSMA	Boreal Chorus Frog	*Pseudacris maculata*		*Pseudacris triseriata*
RACA	Bullfrog	*Rana catesbeiana*		
RAPI	Northern Leopard Frog	*Rana pipiens*		

Species abbreviation	Common name	Scientific name	Alternate common names	Alternate scientific names
SAOB	Chuckwalla	*Sauromalus obesus*		
SCGR	Sagebrush Lizard	*Sceloporus graciosus*		
SCMA	Desert Spiny Lizard	*Sceloporus magister*		
SCUN	Eastern Fence Lizard	*Sceloporus undulatus*		
SPIN	Great Basin Spadefoot	*Spea intermontana*		
SPMU	New Mexico Spadefoot	*Spea multiplicata*		
THCY	Blackneck Garter Snake	*Thamnophis cyrtopsis*		
THEL	Western Terrestrial Garter Snake	*Thamnophis elegans*	Wandering Garter Snake	*T. e. vagrans*
UROR	Tree lizard	*Urosaurus ornatus*		
UTST	Side-blotched Lizard	*Uta stansburiana*		

Appendix 3

Herpetofauna inventory field survey schedule for 2002, with associated personnel

TRIP #	PARK	DATES	CREW MEMBERS	No. SURVEYS
1	ZION	1 – 5 April	RP and JB	15
2	NABR	10 April	RP, DS and JB	2
	BRCA	11 – 12 April	RP and DS	6
	FOBU	12 – 14 April	RP and DS	5
3	TICA	24 April	RP and DS	4
	GOSP	25 April		7
	CARE	26 – 29 April		8
4	ZION	8 – 12 May	RP, DS, BW and BT	17
	PISP	9 – 11 May	RP and BW	19
	CEBR	13 May	RP, DS, BW and BT	5
5	CARE	22 – 27 May	BW and DS	16
	NABR	22 – 24 May	RP	12
6	ZION	5 – 11 June	DS and BW	14
	PISP	7 – 9 June	BW	7
	BRCA	5 – 10 June	RP	17
7	NABR	19 – 21 June	RP and BW	7
	COLM	21 – 24 June	RP and JB	16
8	COLM	7 – 9 August	RP and BW	10
9	GOSP	15-17 August	BW	12
	TICA	18 – 20 August	BW	13
	NABR	23 – 25 August	RP	9
10	CEBR	3 – 5 Sept	RP and BW	9
	BRCA CARE	5 Sept		1
		6 Sept		3
11	BRCA	9 – 11 Sept	RP and BW	6
ad hoc	ARCH	27 March 22 September	ALL	32

RP: Renata Platenberg
JB: Jason Bazzano
DS: David Syzdek
BW: Becky Williams
BT: Brent Trim

Herpetofauna inventory field survey schedule for 2001, with associated personnel

TRIP #	PARK	DATES	CREW MEMBERS
1	ZION	3 – 8 May	RH, RP, JJ
2	CARE	16 – 22 May	RP, RH, JJ, KG
3	ZION	30 May – 1 June	RH, KG
	BRCA	2 – 5 June	RH, KG
	TICA	31 May – 1 June	RP, JJ
	GOSP	1 June	RP, JJ
	FOBU	2 – 4 June	RP, JJ
4	CARE	13 – 19 June	RH, JJ
	ZION	13 – 17 June	RP, KG
	PISP	18 – 19 June	RP, KG
5	CARE	27 – 29 June	RP, RH, JJ, KG
	BRCA	30 June – 3 July	RH, JJ
	CEBR	30 June – 3 July	RP, KG
6	BRCA	18 July	RH, KG
	BRCA	18 – 19 July	RP, JJ, Haskell University students
	ZION	19 – 21 July	RH, KG
	CEBR	20 July	RP, JJ, Haskell University students
	ZION	21 – 22 July	RP, JJ, Haskell University students
	CARE	22 – 24 July	RH, KG
	CARE	23 – 24 July	RP, JJ, Haskell University students
7	BRCA	30 July – 5 August	JJ, KG
	TICA	2 – 3 August	RP, RH
	GOSP	4 – 5 August	RP, RH
	FOBU	6 – 8 August	RP, RH
8	TICA	15 August	RP, JJ
	CEBR	15 – 16 August	RH, KG
	ZION	16 – 21 August	RH, KG
	GOSP	16 – 17 August	RP, JJ
	FOBU	18 – 20 August	RP, JJ
9	CARE	29 August – 4 September	RP, JJ, RH
10	PISP	14 – 15 September	RP
11	CARE	17 September	RP
12	CARE	24 September	RP

R.P.: Renata Platenberg
R.H.: Rebecca Harms
J.J.: Jason Leon Jones
K.G.: Kim Galvin

Appendix 4

Biographical information and qualifications of field survey crew

Renata Platenberg, Crew Leader, 2001 and 2002

Renata obtained her Bachelor of Science degree in Zoology in 1988 from Colorado State University. She completed her Master of Science degree in 1994 in Conservation Biology from the Durrell Institute of Conservation and Ecology at the University of Kent in Canterbury, England, and her PhD in Reptile Ecology from Christ Church College, University of Kent in 2000. She co-founded the Kent Reptile and Amphibian Group in 1994 and acted as Secretary and Coordinator for the group until 1997. She is a member of the British Herpetological Society, the American Society of Ichthyologists and Herpetologists, the Society for the Study of Amphibians and Reptiles, and the British Ecological Society. She has presented papers at numerous meetings, including the Third World Congress of Herpetology in the Czech Republic (1996), the Forth World Congress of Herpetology in Sri Lanka (2001), and, most recently, at the Joint Meeting of Ichthyologists and Herpetologists in Kansas City (2002). Her research interests concern the population biology and ecology of reptiles.

Becky Williams: field technician, 2002

Becky obtained her Bachelor of Science degree from Utah State University in 1999, and is currently working on her Masters degree at USU with Dr. Edmund D. Brodie, Jr. on the ecology of toxins produced by herpetofauna. She has worked as a field assistant for several herp-oriented graduate students and has participated in collecting trips to southern Oregon, northern California, southern California, Nevada, and Utah. Addition field experience includes radio tracking Flat-tail Horned Lizards in the Mojave (southern California). She is a member of the Society for Northwest Vertebrate Biology, the American Society of Ichthyologists and Herpetologists, the Society for the Study of Amphibians and Reptiles, the Animal Behavior Society, and the Society for the Study of Evolution, and has participated in several meetings of these societies. She has contributed four oral presentations and two poster presentations since 1999. Additionally, aspects of her research have been or will be published in the Journal of Herpetology (June 2002), Herpetologica (June 2003), and Herpetological Review (one peer reviewed article and one natural history note; December 2002). Two additional manuscripts are in preparation.

David Syzdek: field technician, 2002

David obtained a Bachelor of Science Degree in Environmental Science, with minors in biology and geology, from the University of Nevada, Las Vegas in 1998. During his

seven-year tenure with Southern Nevada Environmental, Inc. his responsibilities included regulatory environmental compliance monitoring for clients such as Level 3 Communications, the Southern Nevada Water Authority, Nevada Power and Williams, Inc. He also assisted researchers from the National Zoo, University of Florida, University of Nevada and the San Diego Zoo in studying upper respiratory tract disease in the federally protected desert tortoise. He was also instrumental in the development of Clark County's Multiple Species Habitat Conservation Plan, and additional field experience includes work for the University of Nevada, Las Vegas collecting limnological and botanical field data in Nevada. He is a member of the Desert Tortoise Council, Southern Nevada Herpetological Society and Colorado Herpetological Society. David enjoys backpacking, scuba diving, and wildlife photography. He also keeps and breeds reptiles and is especially interested in Australian lizards and has traveled to Australia to photograph them in the wild.

Jason Bazzano: field technician, 2002

Jason obtained his Bachelor of Arts degree in Biology from Whitman College in Washington in 2001. He has since worked with anurans in Sri Lanka and invasive species on Hawaii, and is currently back in Sri Lanka on a Fulbright scholarship. He was primarily employed on the USGS Amphibian Research and Monitoring Initiative project in Canyonlands N.P., but assisted with field surveys in Zion N.P., Arches N.P. and Colorado N.M.

Brent Trim: field technician, 2002

Brent has extensive field biology experience in the Pacific Northwest. He is an experience backpacker, having most recently completed the Pacific Crest Trail solo. He contributed to field surveys in Zion N.P and Cedar Breaks N.M.

Jason Leon Jones: field technician, 2001

Jason completed his Bachelor of Science degree in Biology in 2000 from the University of Utah where he worked for several years under the care and supervision of Dr. John M. Legler as an assistant and undergraduate researcher. His research efforts focused on dietary and reproductive parameters of various southwestern herpetofauna species. While an undergraduate, he also studied with the Organization for Tropical Studies in numerous biology stations in Costa Rica. He has recently been working on the design and implementation of an intensive amphibian and reptile inventory and monitoring program through The Nature Conservancy of Utah's Great Salt Lake Shorelands Preserve. He is currently working on a fire ecology project for the Aldo Leopold Research Institute of the Forest Service, monitoring the distribution of sensitive amphibian species located in prescribed and wildland fire burns. Other field experience includes backcountry instructor, park ranger, and reserve management.

Rebecca Harms: field technician, 2001

Rebecca completed her Bachelor's degree in music in 1997, and spent the 2000 field season working on the Amphibian Research and Monitoring Initiative project in Canyonlands National Park. Other field experience includes amphibian and invertebrate monitoring for Earthwatch and NPS interpretation, also in Canyonlands NP. She is currently completing a Masters degree in invasive plant ecology at Northern Arizona University.

Kim Galvin, field technician, 2001

Kim completed her Bachelor of Science degree in Biology in 2001 from Southern Utah University, having completed an undergraduate project on pothole ecology and another on toad hybridization. She is currently teaching biology at Southern Utah University, and working for the Utah Division of Wildlife Resources.